COMBUSTION

DEVOTED TO THE ADVANCEMENT OF STEAM PLANT DESIGN AND OPERATION

August 1954



Rouge Plant of Ford Motor Company, Dearborn, Michigan

Rouge Plant Modernizes Steam Generation

Determining Fly Ash Size Consist

Case History of a Topping Turbine

Current Status of Demineralizing

"ON THE LINE" PERFORMANCE

50 C-E REHEAT BOILERS

There are 131 C-E Postwar Reheat Boilers in service, under construction or on order, representing an aggregate capacity of 15,497,500 kw or an average of 118,000 kw per unit. The first of these boilers was placed in service in September, 1949. By the end of 1953, fifty units were "on the line." The combined service of these 50 units represents a period equivalent to 66 boiler years. Significant data concerning them are summarized below.

	Total Capacity — kw	
	Average Capacity per Unit — kw	
	Total Boiler — Hours	
	Total Boiler — Years	
	AVERAGE AVAILABILITY 96.2%	
. 8.60 ·	AVERAGE USE FACTOR 91.0%	
	AVERAGE CAPACITY FACTOR 91.2%	
10	20 30 40 50 60 70 80 90 100	
	DISTRIBUTION OF TOTAL OUTAGE PERCENT	
	Inspection	
	Boiler • Superheater • Reheater Economizer • Air Heater • Desuper- heater • Fuel Burning Equipment	
	(Auxiliary Equipment) Valves • Fans • Soot Blowers •	
1.46	TOTAL 3.8%	8-74



Combustion Engineering Building, 200 Madison Avenue, New York 16, N. Y.

SOILERS, FUEL BURNING & RELATED EQUIPMENT, PULYERIZERS, AIR SEPARATORS AND FLASH DRYING SYSTEMS, PRESSURE VESSELS, AUTOMATIC WATER HEATERS, SOIL PIPE

COMBUSTION

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Vol. 26

No. 2

August 1954

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- BPA -

Printed in U.S. A.

STANDARD BOILERS THAT

water storinspection. A ce

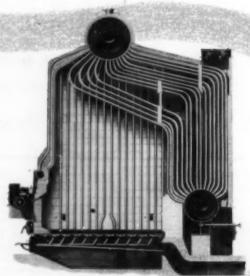
C-E Package Boiler, Type VP

This completely shop-assembled boiler is available in fourteen sizes from 4,000 to 40,000 pounds of steam per hour... for operating pressures up to 500 psi... for pressure firing of liquid or gaseous fuels. The VP Boiler has more water-cooled area per cubic foot of furnace volume than any other boiler of its size and type. The large lower drum — 30-inch diameter — permits a simple, symmetrical tube arrangement ... greater water storage capacity ... easy access for washing down or inspection. A centrifugal fan, which operates at low speed and is exceptionally quiet in operation, is standard equipment. The de arrangement results in low draft loss ... simple soot blowing ...

exceptionally quiet in operation, is standard equipment. The simple baffle arrangement results in low draft loss . . . simple soot blowing . . . no dead pockets . . . high heat absorption. The VP is enclosed in a reinforced, gastight, welded steel casing, and shipped completely assembled with firing equipment, fittings and forced draft fan. For foundation, it needs only a simple concrete slab.

C-E Vertical-Unit Boiler, Type VU-10

The VU-10 is available in nine sizes from 10,000 to 60,000 pounds of steam per hour . . . for operating pressures up to 475 psi . . . superheat to 200 F in 20,000-60,000 lb range . . . for solid, liquid, or gaseous fuels. This boiler is a completely standardized design adaptable to many conditions. It is bottom-supported and needs no outside supporting steel. It operates efficiently over a wide range of output, and is easy to operate and to maintain. All parts are easily accessible for inspection. The VU-10 is a complete unit — boiler, furnace setting, fuel-burning equipment, controls, forced draft, heat recovery equipment (if desired). Regardless of fuel, the same general cross-sectional arrangement of drums, convection bank and furnace wall cooling is used. Uniform design through each transverse section assures even water level in the drum and uniform expansion.

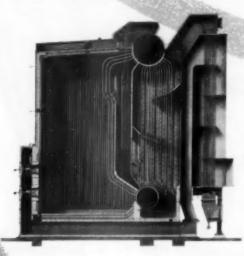


SET INDUSTRY STANDARDS

Whatever your needs for steam may be, in the complete C-E line of fuel burning and steam generating equipment, you will find a type and size just right for your plant.

In the moderate capacity range, for example – that is, from 4,000 to 120,000 pounds of steam per hour – the three completely standardized C-E Boilers shown here offer advantages of economy and over-all performance that make them standout values in their respective fields of application.

These C-E Boilers are manufactured for the highest standards of performance, under a wide range of fuel requirements and operating conditions. Yet, because they are so fully standardized, their cost is well within the reach of the industrial budget.



C-E Vertical-Unit Boiler, Type VU-55

The VU-55 Boiler is available in six sizes from 50,000 to 120,000 pounds of steam per hour . . . for operating pressures of 250 psi or 500 psi in each size . . . with superheat and heat recovery equipment if desired . . . for liquid or gaseous fuels. Like the VU-10, this boiler is of symmetrical design, each transverse section being identical with every other section. Thus the gas temperature entering the boiler bank is constant across the full width of the unit. No outside supporting steel is needed, since the boiler is bottom-supported. The basic design for the VU-55 was originated by Combustion in 1925 and has achieved wide acceptance among steam-power engineers everywhere. Its narrow, high furnace . . . integral design

of boiler and preheater . . . absence of exterior ductwork . . . and the compactness resulting from modern, coordinated design — all help the VU-55 reach a standard of economic performance closely approaching that obtained in large central power stations.

Other C-E Industrial Boilers

In addition to the standard boilers shown here, the Combustion line includes many other 2-drum designs available for capacities up to 350,000 pounds of steam per hour, which can be designed to burn any commercially available fuel. These units are available for use with pressures up to 1375 psi and steam temperatures as high as 960 F. They may incorporate heat recovery equipment of any type, and can be arranged for difficult space conditions. So—whatever your steam needs—call Combustion for details on the complete line of C-E Industrial Boilers.



COMBUSTION ENGINEERING

Combustion Engineering Building, 200 Madison Avenue, New York 16, N. Y.

FLASH DRYING SYSTEMS PRESSURE VESSELS AUTOMATIC WATER HEATERS, SOIL PIPE



"When the Chief Engineer recommmended coal-burning boilers for the new plant, one of the directors asked if coal wouldn't make the plant dirty.

"That made the Chief mad! He didn't say anything at the time, but at the first board meeting after the new plant was finished he invited the directors down for lunch.

"You should have seen their eyes! The place was hospital clean. And why not? The coal came into the stoker through dust-tight chutes, and the ashes were piped out through pneumatic tubes.

"While the directors were eating, the Chief gave them a chalktalk. On one side of the blackboard he had charted the savings through the use of of coal as compared with other fuels. On the other side he had a comparison of our proven reserves of the various fuels showing that while other fuels are growing scarcer, we have barely scratched the surface of our almost inexhaustible coal deposits."

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As the world's largest carrier of bifamiliar with every phase of coal
who will gladly help you to locate
help you use it most efficiently; to
help get it to you promptly.

Write to: Coal Traffic Department Chesapeake and Ohio Railway 2114 Terminal Tower Cleveland 1, Ohio



Chesapeake and Ohio Railway

Only a Heacon Damper offers you this



The Vinat gives you accurate control in the lower flow increments

Heacon Dampers provide the only solution to accurate flow control. With a background of over a decade of application to specialized problems, Heacon Dampers are accepted by engineers as the only means of accurate flow control, particularly in the lower flow increments.

V-porting is the secret. Heacon Dampers may be designed with V-porting to produce practically any flow characteristic from zero to 100%. With conventional dampers barely cracked, a flow of 10 to 20% or more is immediately released with resultant flow control problems in the entire system.

Heacon Dampers are a radical departure

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 Accurate control and ease of operation by either manual or mechanical means.

2.—Positive, tight seal when damper is closed.

The Thermix Corp., Project Engineers for Heacon Dampers are specialists in the application of this damper to your particular requirements. Why not call their engineers today.

Project Engineers

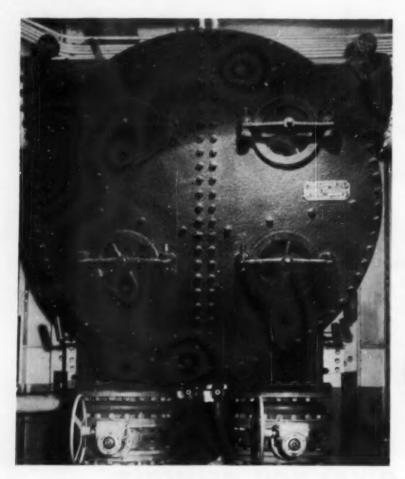
THE THERMIX CORPORATION

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CONDENSERS
USED
AT
FAIRLESS
WORKS
OF



At the Fairless Works of U. S. Steel, Fairless Hills, Pa.
— in the largest integrated steel plant ever built at one time — The Lummus Company has installed two 25,000 sq. ft. surface condensers with air ejectors serving turbo generators, and three 10,400 sq. ft, surface condensers with air ejectors serving turbo blowers.

Each of the 25,000 sq. ft. condensers serves a 30,000 KW turbo generator supplying the steel plant with its power needs. Each condenser is designed for 260,000 lbs. of steam per hour (247,000,000 BTU per hour) at 27.25 inches of mercury vacuum, when supplied with 25,400 gpm of cooling water.

The photograph above shows one of the three 10,400 sq. ft. condensers serving three multi-stage, steam turbine driven blast furnace turbo blowers. Each condenser is designed for 108,000 lbs. per hour (102,800,000 BTU per hour) at 27.25 inches of mercury vacuum, when supplied with 11,000 gpm of cooling water.

All condensers are of the two-pass divided flow type,

each unit being complete with Lummus designed steam jet air ejectors with combined inter-and-after-condenser.

Lummus Heat Exchange Engineers will be pleased to work with you on your next project.

THE LUMMUS COMPANY, Heat Exchanger Division: 385 Madison Avenue, New York 17, N. Y. Atlanta · Boston · Chicago · Rock Island · Cincinnati Detroit · Houston · Tucson · Tulsa · Salt Lake City Minneapolis · Pittsburgh · Rochester · Albany St. Louis · San Francisco · Wayne (Phila.) · Athens Buenos Aires · Honolulu · London · Manila · Toronto Paris · Rome · Lima · San Juan, P. R. · Mexico City Fabricated Piping Division Plant at East Chicago, Ind.

Steam Surface Condensers * Evaporators * Extraction Bleeder Heaters * Steam Jet Air Ejectors * Steam Jet Refrigeration * Barometric Condensers * Heat Exchangers for Process and Industrial Use * Process Condensers * Pipe Line Coolers.



LUMMUS

THE LUMMUS COMPANY HEAT EXCHANGER DIVISION, 385 MADISON AVE., NEW YORK 17, N. Y.

Here's why the Ljungstrom soves fuel...improves boiler performance

1. Saves Fuel — Savings are roughly 1% for every 45-50°F of preheat, since this heat has been recovered in usable form from flue gases.

The Ljungstrom® Air Preheater . . . used in seven out
of ten large boiler installations—is the most compact,
reliable and versatile preheater available. Installed in
a boiler, it leads to the four
well-known advantages listed
at the left.

 Increases Boiler Output — Preheating combustion air increases boiler furnace temperature. Heat absorption into boiler tubes increases at the same time, raising the unit's capacity to produce steam.

3. Increases Boiler Reliability — Preheating leads to more complete combustion of fuel; therefore, less slagging. By burning fuel more completely, it helps boilers stay on the line longer. Furthermore, gases to dust recovery units are cleaner.

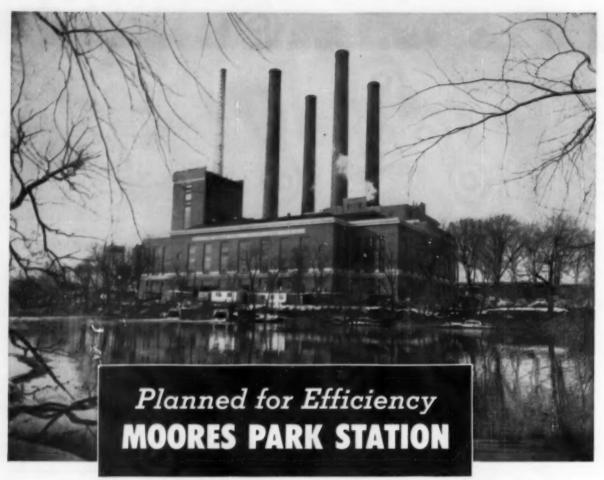
Remember: the ability to deliver these important benefits in full measure is an important reason why more than twice as many Ljungstrom Air Preheaters are specified for large boilers than all other types combined.



 Permits Use of Lower Grade Fuels — Saw and paper mill refuse, wood, lignites, peat, bagasse and similar low-grade fuels become commercially practical when preheated combustion air is used.

WHEREVER YOU BURN FUEL, YOU NEED LJUNGSTROM

The Air Preheater Corporation 40 Sam 42nd Street, How York 17, M. Y.



Moores Park Station of the Board of Water and Electric Light Commissioners, Lansing, Michigan. Consulting Engineers: Burns and Roe, Inc., New York City. Present capacity: 40,000 kw. Future capacity: 160,000 kw.

Efficiency was the keynote in planning the coal-handling system for the Moores Park Station. And, with the accumulated experience of the Lansing, Michigan, Board of Water and Electric Light Commissioners... the consulting engineers, Burns and Roe... and Chain Belt Company Conveyor Engineers... the system was bound to set a new high in efficient operation.

For, when you back up the dependability and top quality of Chain Belt Coal Handling Equipment with the planning skill of this team of experts, you have a combination that results in dependable, low-cost coal handling for years to come.

If you're planning a new coal-handling system, or considering the expansion or modernization of your present one, why not put the Chain Belt Conveyor Experts to work on your team. Just contact your nearest Chain Belt District Sales Office or write direct to Chain Belt Company, 4784 W. Greenfield Ave., Milwaukee 1, Wisconsin.

CHAIN BELT COMPANY

District Sales Offices in all Principal Cities

HALL INDUSTRIAL REPORT

Hall Laboratories, Inc.—A Subsidiary of Hagan Corporation, Pittsburgh, Pa.

Volume 2

AUGUST 1954

Number 4

Investigation from the Ground Up

A recent experience in a large utility plant took Hall Service engineer R. G. Hobek from the basement to the roof to investigate the connection between contaminated boiler water and a peculiar odor that was permeating the entire building.

The No. 2 unit of this plant is rated at 700,000 pounds per hour and is operated at 1500 pounds per square inch. Favorable operating conditions in the equipment at this power station are scrupulously maintained, so the plant men were disturbed when an unusual color showed up in water samples drawn from this boiler. At about the same time, a heavy odor became noticeable throughout the plant.

Mr. Hobek reports:

"We noted the heavy, sweet, organic odor as soon as we entered the building. When the boiler water was checked, it was found to contain a yellowish, well-dispersed material that would not settle, and could not be removed by ordinary filtration.

"We started our examination of the system at the condenser vacuum pump vent line in the basement where the odor was first noted. We followed the line to the roof where it exhausted. In observing the vent lines from the No. 1 and No. 2 units, we saw that the exhaust from the No. 1 unit rose directly to atmosphere while that from the No. 2 unit appeared to be heavier than air and seemed to flow down the outside of the vent line. We climbed to the roof and found that the odor of this heavy exhaust was the same as in the plant. An oily film coated the outside of the vent line.

"The ventilator intake for the plant is located about 50 feet from the vent lines. The fumes were being picked up here and carried throughout the plant.

"We suspected at this point that oil contamination would show up in the condensate and a sample was collected. Analysis of the sample confirmed our suspicion, and investigation by plant personnel showed that a broken weld on the turbine bearing oil return line had admitted from fifty to one hundred gallons of oil to the system."

Cleaning the oil from the system was a big job, but the early solution of the problem prevented real damage.

Waste Water Can Be Costly

Two recent civil suits could have been avoided by proper disposal of waste materials. The outlay for damages and court costs took these plants "off the hook" legally but did not solve their problems.

One plant dumped a water and molasses mixture into a ditch from which it seeped into a well supplying drinking water. The Supreme Court of the state upheld a substantial judgment against the plant, commenting "... one who by permitting pollution contaminates the underground water supply of his neighbor's well or spring, commits an act for which he may be required to respond in damages."

Another plant dumped water saturated with a mixture of dirt, chalk and chemicals into a stream. In sustaining an injunction against the continuance of this practice the Supreme Court of this state said, "The principle is that while water is on the land it belongs to the owner of the land, yet he cannot so use and adulterate it as to interfere with the enjoyment thereof by the next owner and if he does so, he is liable in damages for so using it."

Plant-wide Survey Pays Off

The cooling of precious metal bushings presented a critical problem for production and maintenance engineers in a fiber glass plant. Make-up to the open recirculating cooling system was untreated well water; the high "skin" temperatures encountered in the cooling system aggravated the corrosive and scaleforming properties of this water. Plugging of the restricted cooling channels, resulting in overheating of bushings, was a daily occurrence. Aside from production losses, damage to the bushings was often so extensive that recasting was not possible. New bushings cost several thousand dollars apiece.

A plant-wide water survey by Hall engineer W. J. Reese showed the cooling problem to be sufficiently critical to justify split stream softening followed by treatment with a few ppm of glassy phosphate at a controlled pH. Since adopting this recommendation, the plant has operated continuously for two years without one instance of bushing failure resulting from overheating: this service record exceeds the calculated life expectancy of the precious metal bushings by many times. Probably the life expectancy of the Plant Engineer has also been materially improved.

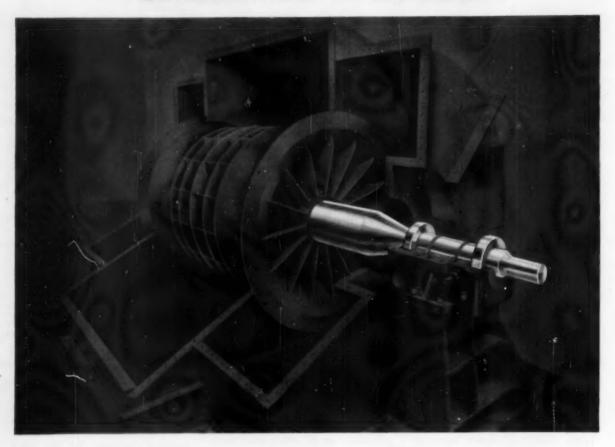
Industrial Water Problems Require Special Handling

There are no "stock answers" to industrial water problems. For information, write, wire or call Hall Laboratories, Inc., Hagan Building, Pittsburgh 30, Pa.

Water is your industry's most important raw material. Use it wisely.

HALL LABORATORIES, INC .- CONSULTANTS ON PROCUREMENT, TREATMENT, USE AND DISPOSAL OF INDUSTRIAL WATER

How a FAN SHAFT Turns Out CHEAPER POWER



... in "Buffalo" Induced Draft Fans

This "Buffalo" Shaft is about to start saving money on a punishing draft job, because it's built for "no-time-out" service! Forged, annealed and precision-ground from a single solid piece of steel, it is oversize, so that its critical speed is well above highest operating speed. Note the substantial thrust collars, ground to fit the bearing very closely. Note

the extra-heavy center portion which will bear the rotor. Here, certainly, is shaft construction to stand all the stresses and heat of high-pressure draft service indefinitely. And there's the same long-life toughness in all other parts of "Buffalo" Induced Draft Fans—the money-saving "Q" Factor—described fully in Bulletin 3750. Write for your copy today!



The "Q" Factor — The built-in Quality which provides trouble-free satisfaction and long life.

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170 MORTIMER STREET

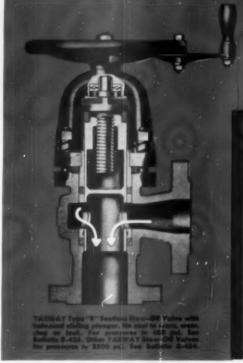
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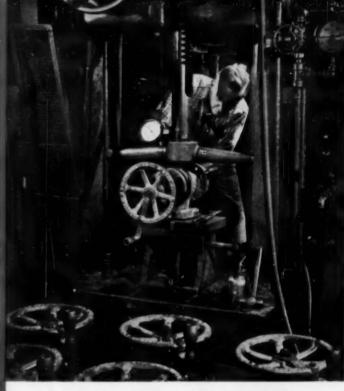
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VENTILATING AIR CLEANING AIR TEMPERING INDUCED DRAFT EXHAUSTING FORCED DRAFT COOLING HEATING PRESSURE BLOWING







THIS PRODUCTION "DOUBLE CHECK" SAFEGUARDS YOUR BOILER INVESTMENT!

■ Yes, here is one extra production step we will never bypass! It is your guarantee of a *dependable*, long-life blow-off valve.

In this corner of the YARWAY Testing Department, every Yarway Blow-Off Valve is hydrostatically tested at 1½ times its rated maximum working pressure—proved drop-tight for service far beyond normal expectancy.

Not only blow-off valves, but all Yarway equipment undergoes rigorous tests before leaving the Yarway plant. Why? For one reason—to assure longer and better service in your plant. Over 15,000 boiler plants are using Yarway Blow-Off Valves—some for twenty-thirty years, or longer.

Whenever you are in need of boiler blow-off valves, be sure to make Yarway your way.

YARNALL-WARING COMPANY

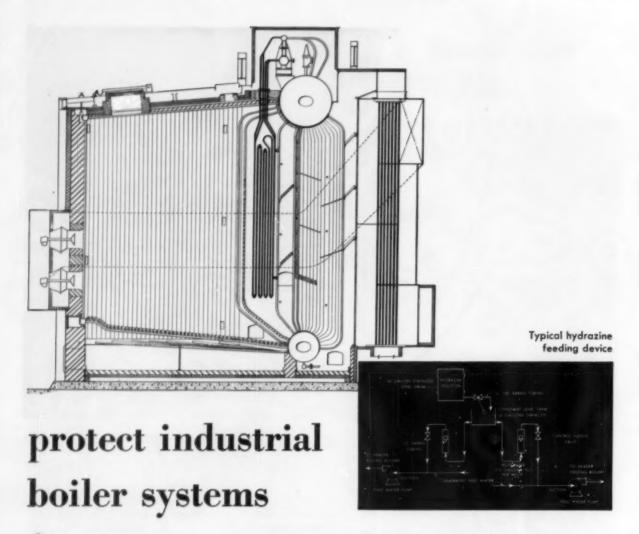
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YARWAY

steam plant equipment

BLOW-OFF VALVES
WATER COLUMNS AND GAGES
REMOTE LIQUID LEVEL INDICATORS
EXPANSION JOINTS

DIGESTER VALVES STEAM TRAPS STRAINERS SPRAY NOZZLES



from oxygen corrosion with HYDRAZINE

To prevent corrosion due to dissolved oxygen in operating boilers, and to protect idle boilers or those in standby service, the use of hydrazine is well established. Hydrazine is now being successfully used in both high and low pressure steam boiler systems—in the industrial boiler field as well as at central power stations—where it provides effective protection at low cost.

Fed in solution, hydrazine is easy to handle and does not seep through hand-hole gaskets; it can be used with existing equipment required for the application of other feed water treating chemicals. Hydrazine reacts completely and rapidly with the dissolved corrosive oxygen, resulting in water and nitrogen; it imparts no additional "total solids" to the feed water. Moreover, hydrazine hydrate is alkaline—a 1% solution of N₂H₄·H₂O has a pH value of 9.9 at 25° C.

These and other advantages of hydrazine for the deoxygenation of steam systems are detailed in Mathieson's literature on the treatment of boiler feed water. Write for this information today.



OLIN MATHIESON CHEMICAL CORPORATION

Baltimore 3, Marylan

2670

MOVES AND COMPACTS COAL - Allis-Chalmers

forque converter tractor with Gar Wood dezer moves coal up to 750 ft, from crusher chute out ever storage pile at Georgia Power Co. plant near Macon, Ga. The 41,000 fb. tractor compacts the coal to eliminate danger of combustion.

MAKE COAL HANDLING

STORES ANYWHERE, RECLAIMS AS NEEDED -

Handling coal with four A-C
Tractors and Gar Wood scrapors permits placing storage
piles wherever there is available space around the Miami
fort plant of The Cincinnati Gas
& Electric Co. Coal is hauled
up to 1700 ft., spread in thin
layers and compacted. The solfleading scrapers efficiently haul
coal as needed to reclaiming
hopper.

STOCKPILES -

HD-5G Tracto-Shovet stockpiles coal as it is unloaded from railroad cars at Crown Cork and Seal Co., Baltimore, Md. Also used to load into trucks.

HELPS UNLOAD -

Canada Cement Co., Montreal, uses HD-5G Tracte-Shovel with dezer to pull coal and coment from sides and ends of ship hold into reach of crane bucket. Eliminates hand shoveling, speeds up unloading.



By Using Versatile Allis-Chalmers Tractors

youcan

Handle all of your coal storing and reclaiming — or supplement existing facilities.

Add storage areas anywhere without installing costly conveyors, tracks, etc.— or abandon them without leaving money tied up in idle equipment.

Speed up handling during rush periods by adding more tractor units.

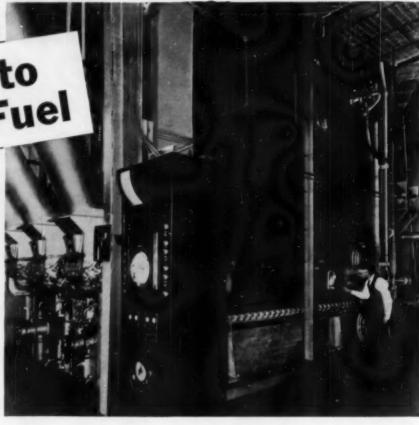
Quickly change storage system or methods...crawler tractors work free of rails and runways, make their own "roadway" anywhere!

Send for free booklet, "Economic Coal Storage with Allis-Chalmers Tractors." Describes modern coal-handling methods, using A-C tractors and 'dozer blades, front-end loaders and scrapers. Write Allis-Chalmers Tractor Division.

ALLIS-CHALMERS

How to Save Fuel

Fuel savings of 15% have resulted from steam plant modernization at General Atilis, Inc., Buffaio, N. Y. The program included this installation of Bailey Meter Control on a 45,000 lb per he, 170 psi spreader stoker-flund boilist.



• The heat energy you get from a unit of fuel depends on the performance of your steam plant equipment. And that's where Bailey controls can help. With a Bailey-engineered control system you can count on a higher output of available energy per unit of fuel. Here's why:

1. Suitable Equipment

When you receive equipment recommendations from a Bailey Engineer his selections come from a complete line of well-engineered and carefully tested products.

2. Seasoned Engineering Experience

Your local Bailey Engineer brings you seasoned en-

gineering experience based on thousands of successful installations involving problems in measurement, combustion, and automatic control.

3. Direct Sales-Service - close to you

For your convenience and to save time and travel expense there's a Bailey District Office or Resident Engineer in or close to your industrial community.

For greater fuel savings, less outage and safer working conditions, you owe it to yourself to investigate Bailey Controls. Ask a Bailey Engineer to arrange a visit to a nearby Bailey installation. We're glad to stand on our record.

for Cutting Production Costs + Bailey Design + Bailey Engineering + Bailey Service = Greater Savings per Fuel Dollar



The shot in the arm!

Engineering

Building any kind of a heat enclosure? Then be sure to call in a specialist. He's the one who has the engineering "know how"—the one who provides the shot in the arm.

And that shot in the arm—engineering—is the vital factor which assures the life of the installation.

Bigelow-Liptak has a team of that kind of engineer. Every job—big or little—is engineered to the "nth" degree. Sound engineering—coupled with top materials and B-L's unique, unit-suspended construction—gives you a job you can be sure of . . . one that has the stand-up stamina for tough, every-day going . . one that costs less in the long run.

Applications? Whenever heat must be controlled: for boiler settings, oil stills, cat crackers, metallurgical furnaces, driers, kilns, inciperators. You can get more information on how to give your "coming up" installation a shot in the arm if you write—today!



BIGELOW-LIPTAK Corporation

2550 W. GRAND BLVD. . DETROIT 8, MICHIGAN

UNIT-SUSPENDED WALLS AND ARCHES

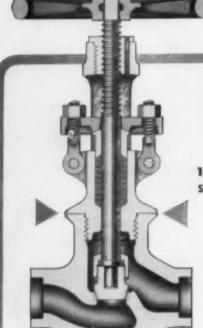
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newest in small steel valves for high-pressure/high-temperature

CRANE lip-seal bonnet (patented) VALVES





Lip Seal design is exceedingly simple. Body and bonnet are screwed together until a firm metal-to-metal contact is made between the smoothly machined flat surface on the shoulder of the bonnet and the top of the body. The small lips around the periphery are then seal welded.

- Absolute Bonnet-Joint Tightness
- Freedom from Bonnet-Joint Maintenance
- Minimum Weight and Bulk
- Easier Dismantling and Reassembly

1500 AND 2500-POUND GLOBE AND ANGLE PATTERNS SOCKET-WELDING AND SCREWED ENDS. SIZES ½ TO 2-INCH

What better way to seal against leakage at the bonnet joint of a small steel valve... than with a simple weld. And that's all the weld is ever called upon to do. Extra-long body-bonnet threads carry all mechanical loads—and at comparatively low stresses. Should dismantling be necessary, the seal weld may be repeatedly ground off—and reapplied—without damage to valve.

Right along with this modern Crane sealing principle go other important refinements. You get a compact, weight-saving structure without sacrificing strength or reducing seat area—a more rigid swivel disc-stem connection—durable Stellite-faced plug-type disc—and Stellite-faced integral seat.

Crane Lip-Seal Bonnet Valves are by far your best buy for high-pressure/high-temperature power services... worthy companions to the larger Crane Pressure-Seal Valves. Ask your Crane Representative for Circular AD1902, or write direct.

THE BETTER QUALITY... BIGGER VALUE LINE... IN BRASS, STEEL, IRON

CRANE VALVES

CRANE CO., General Offices: 836 S. Michigan Ave., Chicago 3, Illinois Branches and Wholesalers Serving All Industrial Areas



VALVES . FITTINGS . PIPE . PLUMBING . HEATING

9 9 9 Forest of Facts RECIRCULATING WATER TREATMENT

ALCO Laboratories' continuous research program has gathered this forest of facts about protecting recirculating water systems. In the search for the most effective and economical formula, the metal rods shown have been rotated in all types of recirculating waters and treating chemicals. Results pointed the way to a group of Nalco Treatments which assure users against scale and corrosion in virtually any recirculating waters. For details on Nalco Treatment to fit your particular system, call your Nalco Representative, or write direct.

Test rad from with the Noles 82 Method shows protective film and freedom from any scaling or corresive

WO 82 METHOD MAY BE THE ANSWER FOR YOU

The Nalco 82 Method is particularly suitable for scale and corrosion control in recirculating water systems which fall within the characteristic limits given here. Check them to see if your system should have Nalco 82 Treatment:

- Equipment to be protected contains steel and/or brass.
- Hardness of makeup water is more than 50 ppm; and sulphates and chlorides, as sodium salts, are less than 150 ppm.
- Colcium hardness of makeup can be as much as 500 ppm.
- Silica content of makeup water up to 50 ppm.
- Total alkalinity of makeup more than 40 ppm.
- Recirculation rates between 100 and 100,000 g.p.m.
- Where non-toxic waste water is required.

Act today to get the certain, low-cost protection of The Nalco System. Full data on Nalco 82 in free Bulletin 68.

NATIONAL ALUMINATE CORPORATION

6234 West 66th Place

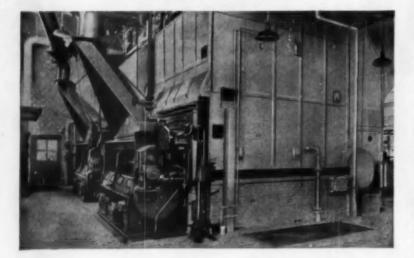
Chicago 38, Illinois In Canada: Alchem Limited, Burlington, Ontario

YSTEM . . . Serving Industry through Practical Applied Science

"COAL'S BEST FOR OUR MODERN PLANT!

It's low in cost...
It's clean and convenient!"

says G. W. Peters, Engineering Manager
M&R DIETETIC LABORATORIES, INC.
makers of PREAM & SIMILAC





"We made a careful study of fuels and burning equipment before building our modern new plant in Sturgis, Michigan. This plant was designed to produce baby food. So the steam plant has to be clean and dust-free as well as economical to operate. Also, we wanted a fuel we could store safely and easily in order to insure ourselves against any shortages.

"We decided on bituminous coal and the up-to-date installation shown here. It certainly fills the bill on every count. Our modern combustion equipment makes coal far more economical than any other fuel. Up-to-date coal and ash handling give us convenient operation completely free of dust nuisance."

Additional case histories, showing how other types of plants have saved money by burning coal the modern way, are available upon request.

Discover for yourself the great advantages of coal burned the modern way. Call in a consulting engineer. He'll show you how today's combustion equipment can give you 10% to 40% more power from a ton of bituminous coal than from equipment used only a few years

ago. He'll show you how modern labor-saving coal and ash-handling equipment make a coal-fired installation clean, convenient, and dust-free.

If you plan to remodel or build a new plant, be sure to look into the low cost and convenience of bituminous coal. Consider coal's other advantages, too. It has reserves that are virtually inexhaustible. America's bituminous coal mining industry is the most efficient and productive in the world. With bituminous coal, you can be sure of plenty of fuel at relatively stable prices now and for years to come.

If you operate a steam plant, you can't afford to ignore these facts!

BITUMINOUS COAL in most places is today's lowestcost fuel, and coal reserves in America are adequate for hundreds of years to come.

COAL production in the U.S.A. is highly mechanized and by far the most efficient in the world.

COAL prices will therefore remain the most stable of all fuels.

COAL is the safest fuel to store and use.

COAL is the fuel that industry counts on more and more—for with modern combustion and handling equipment, the inherent advantages of well-prepared coal net even bigger savings.

BITUMINOUS COAL INSTITUTE

A Department of National Coal Association Southern Building, Washington 5, D. C.

YOU CAN COUNT ON COAL!

0



ARMSTRONG FORGED STEEL STEAM TRAPS!

Because:

- They provide dependable automatic drainage of condensate and boiler carryover for protection of valves, turbines and other equipment.
- 2. They have been thoroughly proved in use in important power plants all over the world.
- 3. Armstrong has built thousands of them since 1929 and has the experience necessary to insure safe design and application. In fact, Armstrong pioneered the development and application of traps for high pressures and has continuously kept pace with the trend to higher pressure plants.
- 4. Generous margins of safety are provided, not only in the forged bodies and caps, but in the power provided for opening the valve and in bucket buoyancy for closing the valve. There is no steam waste and no failure to open.
- 5. The quality is unsurpassed—chrome steel valve and seat are hardened, ground and lapped; other working

Many plants, particularly refineries and chemical processing plants use Armstrong forged steel traps at 250 lbs., or less, pressure to secure the advantages of all-steel fittings and freedom from damage in event of fire or explosion.

parts are stainless; bodies, caps and bolts and nuts are of materials approved for pressures involved.

- 6. The cost is moderate—first cost because of quantity production, long run cost because of low maintenance.
- 7. They are guaranteed to give complete satisfaction. Your local Armstrong Representative is fully qualified to discuss your forged steel trap applications and to answer your questions. Give him a call, or write:

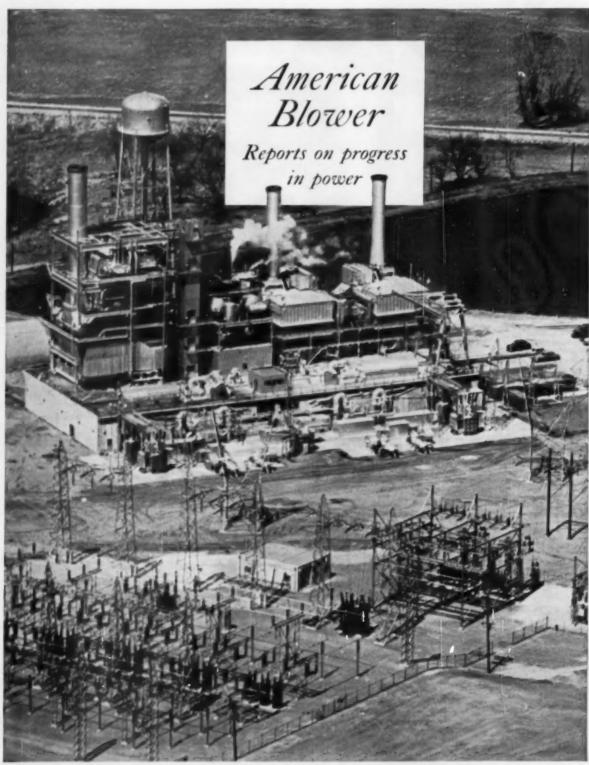
ARMSTRONG MACHINE WORKS 814 Maple Street, Three Rivers, Michigan



FOR COMPLETE INFORMATION

Send for the new 44-page Steam Trap Book — includes physical data and list prices, service pressure rating tables, list of materials and other data partinent to forged steal traps plus information on cost traps and trap selection, installation and maintenance for all condensate drainage jobs. Free an request—no obligation.

ARMSTRONG STEAM TRAPS



Pictured above is the new Southwestern Station of the Public Service Company of Oklahoma, located on the Washita River, 27 miles west of Chickasha,

in the heart of southwestern Oklahoma. This new station assures an abundant supply of dependable electric service for homes, farms, offices and factories.

New power for Western Oklahoma

American Blower helps the Public Service Company of Oklahoma expand to meet increasing electrical needs

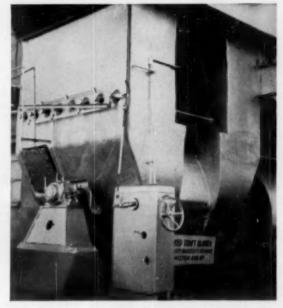
When present expansion plans are complete, the Public Service Company of Oklahoma will have spent \$40 to \$45 million on three new steam generating units, the second of which went "on the line" March 1954. When completed, the three new units will develop a total of 362,000 H.P., enough to make the Southwestern Station one of the largest steam electric generating plants between the Rocky Mountains and the Mississippi River.

This large investment brings more abundant, low-cost electricity—and a new vitality!—to thousands of homes, farms and factories. Naturally, Public Service Company of Oklahoma, a progressive, investor-owned utility, spends wisely.

Careful search found an ideal location; careful selection assured the finest, most efficient, most economical equipment . . . including American Blower Forced Draft Fans.

It is significant that Public Service Company of Oklahoma chose American Blower Equipment. Like so many other leading power companies, who use American Blower Mechanical Draft Fans, Heavy-duty Steam Coils, Fly Ash Precipitators and Gýrol Fluid Drives for boiler feed pump and fan control, the Public Service Company of Oklahoma knows it can depend on American Blower equipment.

If you plan to modernize or expand your facilities, contact your nearest American Blower Branch Office, or write us direct.



Outdoor installation of American Blower Forced Draft Fan. It is well protected against hail, dust, sand and snow. American Blower Engineers, with their wide experience, can help with your power problems. Give them a call.



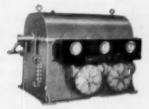
Mechanical Draft Fans for induced and forced draft



Collectors and precipitators for dust and fly ash control



Heavy-duty steam coils for high pressure duty



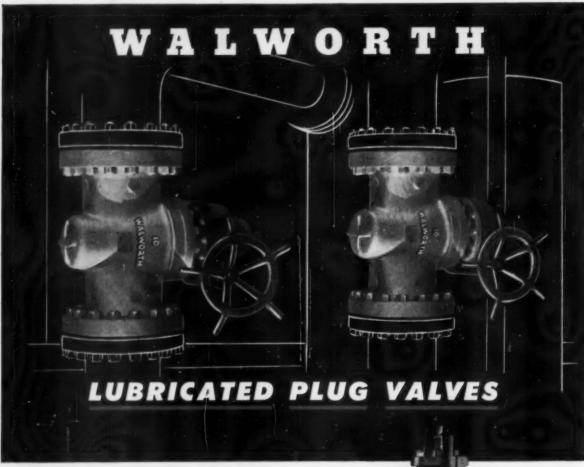
Gyrol Fluid Drives for boiler feed pump and fan control

AMERICAN BLOWER CORPORATION, DETROIT 32, MICHIGAN . CANADIAN SIROCCO COMPANY, LTD., WINDSOR, ONTARIO

Division of American Radiator & Standard Sanitary Corporation



WALL TILE • DETROIT CONTROLS • KEWANEE BOILERS • ROSS EXCHANGERS • SUNBEAM AIR CONDITIONERS

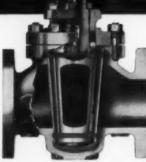


Better because... They are pressure sealed with an insoluble lubricant readily renewed while the valve is in service. Lubricant completely surrounds the plug ports assuring a tight seal against leaks. It also insures ease of operation by reducing friction between the body and the plug while at the same time protecting the finished surfaces against corrosion and wear.

Walworth Lubricated Plug Valves are the most satisfactory valves available for the handling of gritty suspensions, and many other destructive, erosive, and corrosive industrial and chemical solutions.

They are ideal for general refinery and pipeline service.

For full information see your Walworth Distributor, or write for your copy of Bulletin 111. Walworth Company, General Offices, 60 East 42nd Street, New York 17, N. Y.



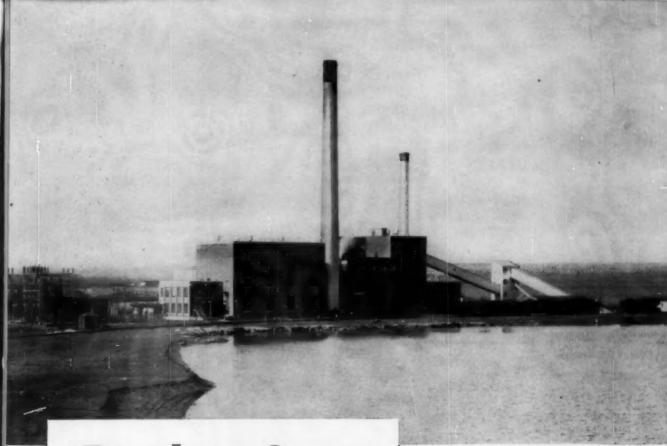
Lubricant system of a Walworth No. 1700F Regular Gland, Wrench Operated, Steel-iron, Lubricated Plug Valve. Other Walworth Lubricated Plug Valves include Single Gland, and Ball Bearing types. Sizes to 30-inches — pressures to 5,000 psi, and for vacuum service.

WALWORTH

Manufacturers since 1845

valves . . . pipe fittings . . . pipe wrenches 60 East 42nd Street, New York 17, N. Y.

DISTRIBUTORS IN PRINCIPAL CENTERS THROUGHOUT THE WORLD



coal handling at Ashland

● The illustration above shows the first 38,600 KW unit of a plant which is to be extended into a 60,200 KW station. Coal is received by lake boat at a near-by deep water dock, and carried to the plant in railroad cars. All handling facilities including the track hopper and grillage, duplex feeder, conveyors, gallery, chutes, tripper and all supporting structures, were fabricated in our shops and installed by our erectors to Sargent and Lundy specifications. For maximum efficiency and fixed unit responsibility, let the Bartlett-Snow coal handling engineers work with you on your next job.

DESIGNERS

ENGINEERS



FABRICATORS

ERECTORS

"Builders of Equipment for People You Know"

General View of Bay Front Steam Plant Lake Superior District Power Co. Surgent and Lundy Consulting Engineers



150 Ton Per Hour Ring Roll Crusher Showing By-Pass Gate and Drive



Belt Conveyor Showing Automatic Weightometer and Vertical Take-up

Trying to reduce piston packing maintenance? J-M Pump Cups after removal from feed water pumps at Morgan Laundry. Set above consists of 2 J-M "A Cups with spacer and 2 followers, mounted on pump rod At the Morgan Laundry, J-M Moulded Packings provide "8 times longer life-

replacement in 1/6 the time

The Morgan Laundry, large supplier to hotels and institutions, requires dependable, trouble-free service from boiler room equipment. In their New York City plant, the Engineering Department found that conventional piston packings for boiler water feed pumps lasted only a relatively short time. Many hours of down time were required to replace packings. Liner wear became progressively worse.

When the Engineering Department changed from the conventional material to J-M Moulded Packing Cups, service life of the packing was increased more than 8 times. Liner wear was greatly reduced. Replacement with the new packings was made in 1/6 the time. Packings could be easily installed for proper service, without special skill or experience. Satisfaction with this application has led to the use of J-M

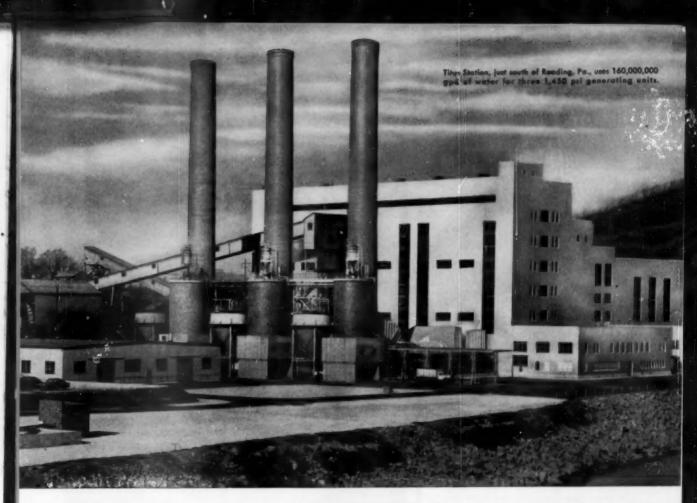
Moulded Packing Cups on other boiler room equipment and on presses in the Morgan Laundry plant.

These precision moulded packings offer definite advantages over conventional types. Because they form a highly efficient seal, they contribute to improved performance, lower operating and maintenance costs. For steam pump pistons, they are available in sets consisting of two cups and two followers, with a spacer. This pump cup set, J-M Style 80, is similar to that shown in the illustration above.

Your Johns-Manville Packings Distributor can help you make the right selection for your application, from Johns-Manville's line of custom-made Piston Packing Cups. For complete details write him or Johns-Manville, Box 60, New York City 16. In Canada, 199 Bay Street, Toronto 1, Ontario.



Johns-Manville PACKINGS & GASKETS



METROPOLITAN EDISON BOOSTS CAPACITY BY 240,000 KW!

Latest \$35,000,000 investment is protected by Permutit-conditioned water

Sheathed in aluminum—this silver giant is the last word in reliability and design.

Titus Station's output almost equals that of 5 other Metropolitan Edison Company stations. Permutit was selected to protect this important plant from untreated Schuylkill River water . . . turbidity of 700 ppm, hardness up to 180 ppm, high iron and manganese.

Two Permutit Precipitators remove trouble-making suspended solids, give clarified water for bearing cooling, oil coolers, etc. Part of this water goes on to Permutit filters and softeners . . . comes out crystal clear and completely softened for more critical uses.

You can get this same protection for your plant. We will be glad to supply helpful information on your particular water problems. Write today.

The Permutit Company, Dept. C-8, 330 West 42nd St., New York 36, N.Y., or Permutit Company of Canada, Ltd., 6975 Jeanne Mance Street, Montreal.

PERMUTIT

Water Conditioning Headquarters for Over 40 Years

PRECIPITATORS reduce turbidity of Schuylkill River water from 700 to below 10 ppm in one fast operation.

GRAVITY FILTERS remove final traces of suspended impurities . . . using Anthrafilt to eliminate silica pick-up.





AUTOMATIC SOFTENERS deliver completely softened water. Regeneration is automatic . . . saves time and money.

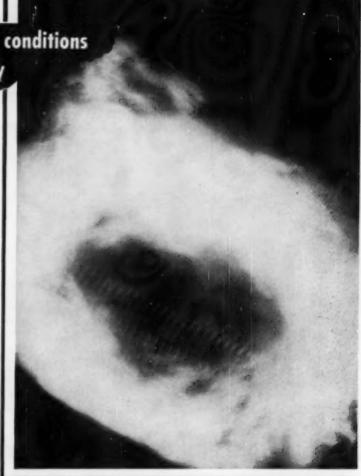


Now watch combustion conditions every minute of the day

... with RCA Industrial TV

With RCA's new water-cooled window—you maintain continuous observation of flame conditions and ignition—at the control panel—24 hours a day. High-detail picture eliminates the need for periodic observation of furnace and checking burner operation.

Water-cooled window can be installed at top of furnace to observe tangential firing—in side of furnace to observe direct firing. High-capacity blower and pump unit can serve two windows.





Here's the answer to continuous, low-maintenance, fail-safe observation of furnace conditions...high-detail RCA Industrial TV (ITV-5A) and the new RCA water-cooled window.

By using a high-efficiency circulating system, RCA has reduced lens temperatures at the camera below 120° F—for stable, dependable camera operation.

The RCA Industrial TV water-cooled window is a reliable tool for use by your operators for continuous remote observation of combustion conditions. RCA now offers this new revolutionary equipment as a complete, engineered package to power plants—plus installation and maintenance service.

FOR INFORMATION ON RCA Industrial TV (Type ITV-5A), write Radio Corporation of America, Dept. H-187, Building 15-1, Camden, New Jersey.

INDUSTRIAL PRODUCTS

RADIO CORPORATION OF AMERICA
EMBINEERING PRODUCTS
CAMDEN, N. J.

In Canada: RCA VICTOR Company Limited, Manired

Consider the unique K-weld technique... when critical piping is the order!

View of inside of pipe, showing root bead. Note the highly uniform, crack-free surface obtained through use of K-Weld method.

With today's operating conditions already approaching the limits of available power piping materials, the necessity for expert fabricating techniques cannot be over-stressed. And it is here that the K-Weld* process, Kellogg's unique welding method, has already played

an important part.
For example, K-Weld was used throughout—both in the shop and in the field-for the welding of austenitic stainless steam piping for service at 1100°F and 2350 psig on two 145,000 Kw units in Kearny Station of Public Service Electric and Gas Co. of New Jersey. It is also being employed in the critical piping for a similar unit at the Company's Burlington Station.

Main advantage of this new welding process lies in the fact that it assures complete penetration without backing rings. Their elimination precludes the possibility of crack propagation at the weld root which would produce ultimate failure as a result of severe operating conditions.

An additional advantage is the elimination of the possibility of the backing ring breaking off and damaging equipment. Furthermore the lack of a ring materially reduces turbulence in pipes.

The K-Weld process—developed in Kellogg's Welding and Welding Practices Group—entails the use of inert-gas are welding of the first pass with inert-gas under controlled pressure on the inside of the piping. It permits an average welder qualified for inert-gas are welding to obtain excellent results either in the field or in the shop. The K-Weld technique may be used on all power piping materials.

Fundamental development work leading to advances in the art of fabrication is an important part of Kellogg's basic stock in trade. Many power station de-signers and utility companies also say it's one basic reason why they time and again specify Kellogg when critical power piping is the order.

New Power Piping Booklet Published . . . Send for descriptive literature about Kellogg's extensive facilities for assuring the highest quality workmanship. A section of the booklet is devoted to detailed coverage of the K-Weld

OTHER FABRICATED PRODUCTS include: Pressure Vessels . . . Vacuum Vessels . . . Fractionating Columns . . . Brums and Sholis . . . Heat Exchangers . . . Process Piping ... Bends and Headers ... Forged and Welded Fittings

These leading companies are among the many major producers of power who use M. W. KELLOGG POWER PIPING.

- Metropolitan Edican Co. Mexican Light & Power Co. (Mexico)
- Munengahela Power Co.
- New York State Electric & Gas Company
- Wingara Mohawk Power Corp. . Palestine Electric Corp., Ltd. (Israel)
- . Philadalphia Electric Co. . Public Service Co. of Harthern Illinois

FABRICATED PRODUCTS DIVISION THE M. W. KELLOGG COMPANY

PULLMAN



TEMPERATURE

MIGH PRESSURE

PIPING



TEMPERATURE

HIGH PRESSURE

PIPING



HIGH TEMPERATURE

PRESSURE

DOWER PIPING



TEMPERATURE

PRESSURE

POWER PIPING

* Trade-mark of the M. W. Kellogg Company.

Fuel Economy for EVERY SIZE OF

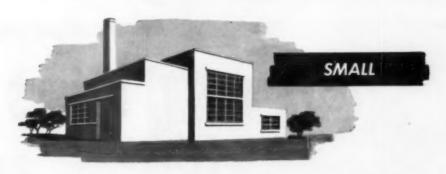
Fuel economy is just as important for the small or medium-sized boiler plant as it is for the large plant. For any number or size of boilers, at any steam pressure and temperature, Hagan Automatic Combustion Control and Ring Balance Instruments Systems are designed to attain the maximum economy of fuel.

The systems used in smaller plants need not be as elaborate as in the larger plants, but all must meet the highest standards of performance.

Whether simple or more extensive, every Hagan system is the assembly of accurate and dependable units in a coordinated system requiring minimum maintenance. The fuel savings normally pay for the system within the first year. Subsequent savings are clear profit.

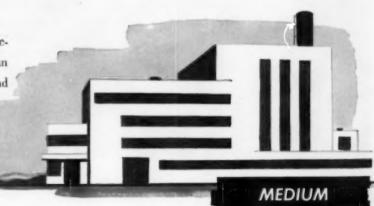
Hagan engineers will be glad to show you how Hagan Automatic Combustion Control and Ring Balance Instruments can be fitted to your exact needs, and can save your fuel dollars.

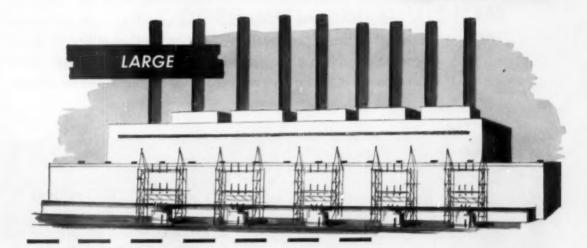




BOILER PLANT

Save fuel—and keep steam production costs down—by installing Hagan Automatic Combustion Control and Ring Balance Instruments in your boiler plant.



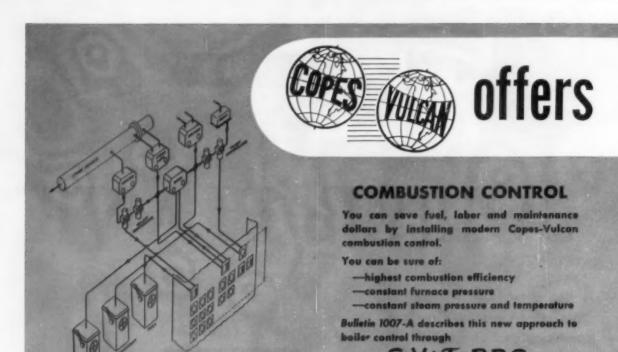


HAGAN CORPORATION

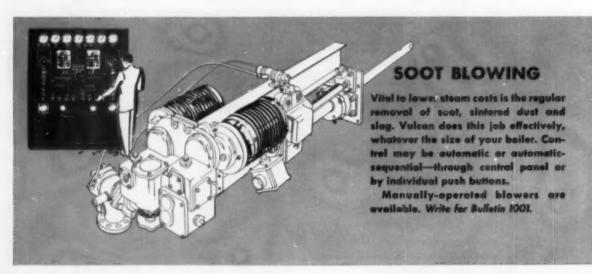


HAGAN BUILDING . PITTSBURGH 30, PENNSYLVANIA

Boiler Combustion Control Systems • Ring Balance Flow and Pressure Instruments • Metallurgical Furnace Control Systems Control Systems for Automatic and Aeronautical Testing Facilities



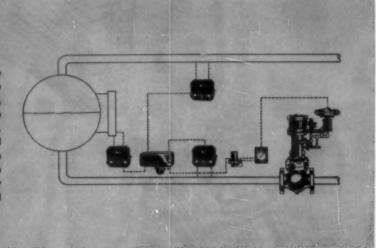
Reduce your steam costs. Get more efficient and safer boiler operation. Use one or more of these four Copes-Vulcan aids to offset rising costs of fuel, labor and maintenance. C • V + T offers a new approach to boiler control—with undivided responsibility from analysis to installation—and service wherever needed for the life of the installation.



4 aids to lower steam costs

FEED WATER

Copes feeds exactly as needed to maintain correct water level while meeting steam demands. Three-, two- or one-influence systems are available for your specific needs. Control may be independent, or tied in with combustion control. Take a look at the newest three-influence COPES instrument-type feed water control system—Type 3-L, described in Bulletin 1013.





COPES-VULCAN DIVISION

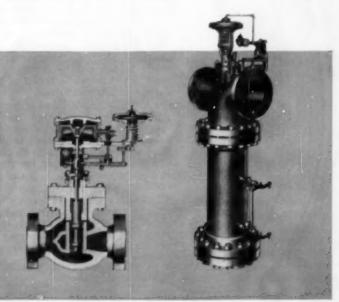
CONTINENTAL FOUNDRY & MACHINE COMPANY

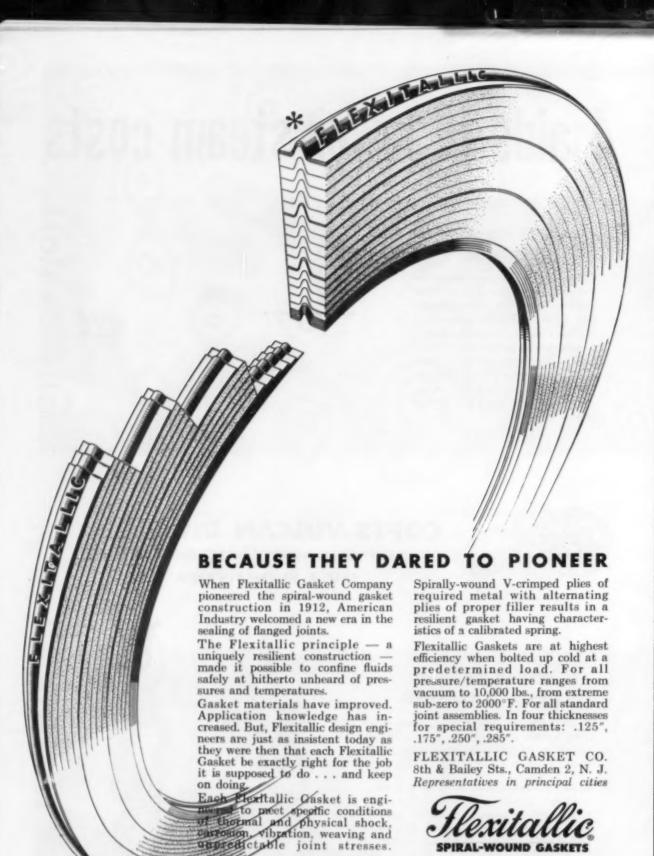
ERIE 4, PENNSYLVANIA

REDUCING and DESUPERHEATING

Copes Reducing Valves have ports characterized for specified flow and pressure conditions. Rugged construction throughout. Write for Bulletin 477-A.

Copes Desuperheaters are self-contained, need no "extros" for installation. Temperature control is accurate, even on lightest flows, because cooling water is fully controlled inside the chamber. Bulletin 405-C.





THE FLANGES, PRESSURE VESSELS AND PROCESS EQUIPMENT

SPIRAL-WOUND GASKETS

COMBUSTION

Editorials

More Legislation for Air Pollution Control

An exploratory conference on intra-state air pollution problems was called by the Joint Legislative Committee on Natural Resources of the State of New York for August 5 in Albany. An invitation of sorts was issued to draw a good cross section of interests, but no public announcement was made. About 100 individuals representing all phases of the air pollution control problem made it their business to attend. One came from as far away as California, others from Ohio and Pennsylvania. And the reason for such a turnout in the middle of the vacation season is obvious. Any legislative program adopted by the State of New York could well set a pattern that much of the nation would follow.

From the welter of opinion and comment one recommendation stood out. It was the statement by Harold Keller, New York State Commissioner of Commerce. We quote: "The Joint Legislative Committee on Intrastate Cooperation, from which the Committee on Natural Resources stemmed, made a major contribution in the field of water pollution. It invited and received the cooperation of industry, which proved conspicuously helpful and constructive. The Water Pollution Control Law and the Board which administers this Law are a direct result of this joint effort. Through this law, New York State has already made great strides in cleaning up the pollution of its lakes and streams. It has done so without any undue hardship on individuals, communities or business. I suggest that the problem of air pollution is a parallel one which might lend itself to similar treatment." Then followed a five-step recommendation, namely

1. Establish some workable definition of air pollution so a study group can "inventory" chronic conditions and identify source or sources in each instance.

Analyze the effects of air pollution not only in public health terms but in damage to real or personal property and hazards to aviation.

Study and identify local laws on air pollution as to their applicability on a state-wide basis.

 Analyze the experience of other states and study their laws and agencies.

Correlate these investigations with others under way on inter-state problems since any New York metropolitan area air pollution survey must recognize this aspect.

The above five-step recommendation embodies a sober, well-studied approach to a problem whose eventual solution will unquestionably be a series of compromises. How fair or how lasting these compromises will be depends on how well grounded the studies are that prompted them.

We earnestly hope the New York legislators will ponder long over this problem and not act hastily. In the words of Mr. Keller "... I urge the constructive help of industry be solicited so that the end result will be a stimulant rather than a deterrent to the economy of our State." These are praiseworthy sentiments and we feel an excellent guide not only in framing any future air pollution control laws but in administering them as well.

Why Limit Engineering to Engineers?

In the last decade engineering curricula in many colleges and universities have been broadened to include more studies in the fields of liberal arts. Many advantages result from this arrangment. The engineering student is required to think along lines other than his specialized technical interests. He has the opportunity to gain an appreciation of art and literature, to become acquainted with the great leaders in political science and philosophy and to gain at least an introduction to the rapidly developing social sciences. All of this should be an aid to making the engineer of the future a better educated citizen.

But many engineering students, especially those attending institutions having a number of professional schools, are prompted to ask whether a knowledge of technology would likewise be an asset to non-engineers. Why not acquaint future lawyers, teachers and merchants with engineering—its methods and its impact upon contemporary life?

At least one university has recognized this need. Last May Professor Jerry S. Dobrovolny presented a paper before the Illinois Academy of Sciences in which he described a pioneering course in the philosophy and methods of engineering which was offered to non-engineers at the University of Illinois on two occasions last year. Here are some of the topics that were discussed in the course: typical problems solved by engineers and methods used in their solution; a historical account of the development of engineering; and responsibilities of the engineering profession in social, economic and technical matters.

Although only in its first year, this course has already proved of measurable utility to students in three fields: future teachers who will have to counsel secondary-school students interested in engineering, students planning to enter government service, and law students who plan to specialize in patent or corporation law. It also has potential liberalizing value for other non-engineering students who wish to learn how technology has come to assume its present importance and influence.

Engineering methods are of potential use to many who are outside the profession. It is to be hoped that this pioneering course at the University of Illinois will induce other engineering schools to introduce similar studies so that engineers and their methods will find wider understanding by students in many fields.

ALL ORIGINAL BOILERS DESIGNED FOR 200,000 LBS PER HOUR, 240 PSIG, 650"



EACH REBUILT FOR 380,000 LBS PER HOUR (500,000 PEAK)

1926,	1929	1929	1925
BOYLER	BOILER	BOILER	BOOLER
NO. 8	NO. 6	NG 4	960 2
	(IIIIIII)	minh	
	1996	1999	1954
		EPLACED BY A 500,0 UR 250 PSIG, 650°	

FIGURE NO 1 CHRONOLOGICAL STEPS IN MODERNIZATION OF STEAM GENERATION AT POWER HOUSE NO 1, FORD MOTOR COMPANY, DEARBORN, MICHIGAN

Fig. 1—Above block chart shows how the major elements of the boiler room have been periodically improved to meet the plant steam needs efficiently



Fig. 2—In addition to the boiler improvements watertreatment sids like sedimentation tank, left; ash handling equipment and silos, right, are going into service as needed

Rouge Plant Modernizes Its Steam Generation

The Rouge Plant of the Ford Motor Co., Dearborn, Mich., has consistently kept abreast of fuel-burning and steam generation progress since its construction in 1920. Here is the latest in a series of modernization steps, all within the original floor space, that will see the original equipment quadrupled in capacity with all but one of the original boilers replaced.

TEAM generation is again undergoing modernization at the world-famous Rouge Power Plant. The present program includes: (a) replacement of low pressure units No. 2, No. 4, and No. 6, with 600,000 lb per hr steam generating units operating at 250 psig, 650 F: (b) installation of dust collectors and fly ash and bottom ash-handling equipment for all eight units, including 600-ton fly ash and 150-ton bottom ash storage silos; (c) installation of a 200,000 gallons per hour hot lime process softener system, including filters, hot zeolite softeners, 1,500,000 lb per hr thoroughfare type deaerating heater, and low pressure boiler feed pumps. The engineering and construction is being done by The Kuljian Corporation, engineers and constructors, Philadelphia, Pa., under the supervision of J. A. MacAlarney, Director, Plant Engineering Office, Manufacturing Staff of Ford Motor Company, Dearborn, Michigan.

History

The Rouge Power Plant, also known as Power House No. 1, has always had greater steam capacity than any other industrial power plant. Fig. 1 portrays the chronological steps in modernization of its steam generating equipment. Within thirty-five years, the most modern industrial power plant of its time will have replaced all By L. F. O'REILLY

Project Engineer, Ford Motor Company

and W. J. FADDEN, JR.

Project Engineer, The Kuljian Corporation

except one of its original boilers nearly quadrupling its original capacity; and all this accomplished within the same floor space occupied by the eight original units.

The original low pressure units, installed in 1920, were the largest ever built up to that time and were the first large units designed to use pulverized coal as the primary fuel. Although the original furnaces had solid walls, capacities of 200,000 pounds of steam per hour could be maintained.

By 1925 Ford production had increased considerably. There was a tendency toward greater concentration of production at the Rouge Plant, so much so that raw materials were completely converted into the finished product, which moved under its own power from the end of the assembly line. With this increase in production power requirements climbed and the low pressure boilers originally used for electric generation were in need of help to increase their capacity. The coal-burning capacity was doubled by doubling the number of burners. Next, lining the inside of the furnace with steam generating and steam superheating surface produced essentially a radiant heat boiler entirely independent of the original convection boiler. The remodeled units (four of the original units) were designed for 380,000 lb per hr of steam but in practice, an actual peak evaporation of over 500,000 lb per hr was attained. The efficiency of the re-

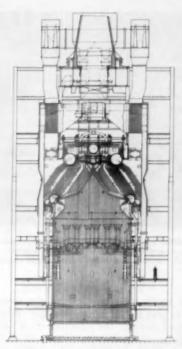


Fig. 3—Cross-sectional view of the first twin boiler installation, a 600,000 lb per hr. 250 psig. 650 F design, now going in on the current modernisation program



Fig. 4—New boilers employ twelve coal feeders to the tangential burners, six to each side. Here is a close-up view of some of the coal feeders and drives. The feeders are located below the pulverised coal bunkers

modeled unit, as compared with the original unit, was raised from 80 per cent to approximately 84 per cent at rated load. The new low pressure units (1954–1955–1956 replacements) are to have an efficiency of 86.5 per cent.

By 1929, Ford production was again taxing the capacity of the power plant. But progress by this time permitted a better solution than further remodeling of the remaining four original units. Two of the original units were replaced with high pressure units which, when completed in 1931, were the largest in the world. The two remaining completely original units were replaced in 1936 and 1939, respectively, with again the largest capacity high pressure units in the world.

The steam generated by the high pressure units now supplies electric generation needs solely. The steam generated by the low pressure units handles the balance of the plant needs such as driving the turbo-blowers, process purposes, various plant uses, and building heating. An increasing demand for low pressure steam and the age of the existing low pressure units, however, has led to the present replacement of three of these units. It is contemplated that the remaining low pressure unit will be replaced with a high pressure unit soon.

Steam Generating Unit No. 2

Steam generating unit No. 2 has just been completed and is, at the time of this writing, ready for operation. The steam generator consists of two Combustion Engineering, Inc., two-drum bent tube boilers (so called twin boiler) installed over a common water cooled furnace. Each boiler feeds into a common dry drum which is connected to separate superheaters, one for each boiler, Fig. 3. The superheaters connect in turn, to individual superheater outlet headers, then to a common desuperheater

header. The unit is designed to operate at 250 psig pressure and 650 F at the superheater outlet.

A bank of burners in each corner fire tangentially into the furnace, Figs. 4 and 5. These units can burn pulverized coal, blast furnace gas, coke oven gas, and oil (future) individually or in any combination at one time. For combustion control purposes, only the combination of blast furnace gas and pulverized coal is considered. Bunker "C" fuel oil for future firing will be under automatic combustion control. Coke oven gas, planned primarily for pilot flame only, is used for warming up purposes, however, and on week-ends to enrich the b. f. gas.

Blast furnace gas pressure is normally regulated so that all other users in the plant get preference and the boiler house uses the surplus. Each boiler unit derives its supply from two 36-in. gas mains; each main, equipped with its own flow measuring orifice, serves a pair of corners. A totalizing type meter records the blast furnace gas flow to the unit. The maximum capacity of the unit when firing blast furnace gas is 500,000 lb per hr of steam. Pulverized coal from the existing bin system is fed to the burners by twelve feeders, each driven by a 250-v variable speed, direct current motor. Two primary air fans are provided, each using preheated air, and each equipped with inlet control damper and outlet shut-off damper. Primary air feeds into each pulverized coal fuel line immediately below each feeder. The capacity of the unit when firing pulverized coal is 600,000 lb per hr.

The steam generating unit has two double inlet type forced draft fans with inlet vanes for control purposes and remote manually operated outlet dampers for low loads. Heated air is partially recirculated to the forced draft fan inlets under the local regulation of manually operated dampers. The forced draft fans employ con-

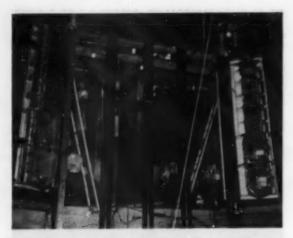


Fig. 5—Excellent construction view shows two of the four tangential burner assemblies with coal feed at top and blast furnace gas supply through side boxes



Fig. 6—Exterior view of completed blast furnace gas ductwork shows operating floor push button station, coke oven gas control, center, and blast furnace gas control, right

stant speed motors for drives and discharge into a common plenum chamber.

Two induced draft fans are provided and constant speed motors drive them. Control is effected by inlet louver dampers. The fans discharge into the base of the existing 168 ft high, steel stack supported on the roof of the plant. Each steam generating unit in the plant is

provided with an individual stack.

Steam generating unit No. 2 carries two economizers, two tubular type air preheaters, and two mechanical Aerodyne type dust collectors. One collection system is provided for the east halves of both dust collectors (another for west halves), including cyclones, soot hopper and secondary air fan. Each secondary air fan discharges into the inlet of one dust collector. Each dust collector is provided with motor operated rappers and remote manually operated by-pass dampers. The dust collectors meet the requirements of the City of Dearborn, Michigan, and are guaranteed as having a fly ash emission of not more than 0.2 gr per cu ft reduced to the design stack temperature when firing 100 per cent pulverized coal. The efficiency is expected to be 92 per cent with a pressure drop through the collector of 1.6 in. of water.

The steam generating unit can operate at reduced capacity with one forced draft fan, one primary air fan, one induced draft fan, and one dust collector secondary air fan. However, both economizers, both air preheaters, and one half of each dust collector must be used.

Soot collected in the rear pass hoppers is reinserted into the corners of the furnace with the use of soot exhausters operated by compressed air.

Combustion Control System

Pulverized coal firing. The automatic combustion control system provides complete regulation of pulverized coal supply, forced draft, primary air, and induced draft on the unit. The fuel supply and forced draft are controlled through the master controller in accordance with the steam demand as indicated by changes in the steam pressure.

The forced draft control depends upon regulating the inlet vanes on the forced draft fans with remote manual secondary adjustment of the outlet dampers. The control of the vanes is determined by the steam flow-air flow ratio to give maximum combustion efficiency.

The control drive on the inlet louvers of each induced draft fan responds to changes in furnace draft so as to maintain a predetermined draft at a designated point in the furnace.

Controlling the speed of the individual d-c motor operated coal feeders regulates the coal supply. Each motor has its own field rheostat capable of individual adjustment; however, these rheostats mount in a way that they all can be operated by one control drive. The starting controls for the feeders are so arranged that groups of two feeders can fire opposite corners of a pulverized coal elevation at the same time. A solenoid air valve operating on 250-v d-c for each coal feeder assures that in the event of current failure the air supply to the individual air cylinder operated primary air valve would cut off and the primary air to the particular burner stops.

The primary air fans have their inlet dampers controlled from the duct pressure to maintain a predetermined pressure regardless of the number of burners.

Blast furnace gas firing. Provision is made for the complete regulation of blast furnace gas supply, forced draft and induced draft, in addition to steam pressure. The methods of controlling steam pressure, forced draft and induced draft follow the same scheme and are applied on the same drives as for pulverized coal.

Blast furnace gas is controlled by adjusting the flow of gas through eight 24-in. butterfly valves, each feeding a burner, Fig. 6. A shut-off damper adjacent to each burner to prevent flash backs is remote manually operated. Since the blast furnace gas pressure to the plant varies, two 36-in. butterfly valves, one in each branch feeding the unit, regulate and maintain a constant pressure prior to the control valves.

Coke oven gas firing. The air register for the coke oven gas burners requires manual adjustment for proper combustion based on an Orsat reading. This air setting must be changed if the set amount of coke oven gas is decreased or increased. One automatic pressure control valve is provided for each bank of coke oven gas burners.

The air operated combustion control system is capable of being partially or completely operated manually.

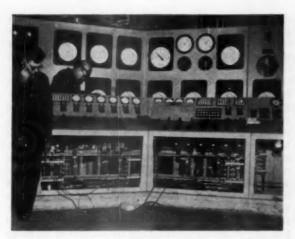


Fig. 7—Units No. 2 and No. 4 will have a common control room. First, or Unit No. 2 board, appears above as it looked during construction phase

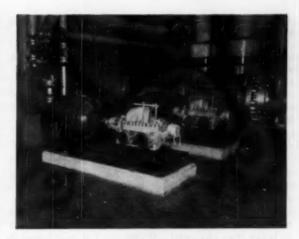


Fig. 8—Boiler feed pumps, shown in the background, are for the existing high pressure boilers. New desuperheater pumps appear in foreground

Steam Temperature Control

For pulverized coal firing the operator sets the tilting angle of the burners to produce as closely as possible the required temperature at the superheater outlet. The two-element system then refines the adjustment of this temperature to accomplish the required exit temperature. For other fuels the two-element system completely controls the temperature of the steam leaving the superheaters. The desuperheating unit is a steam-assisted spray type. Measuring elements used to control the exit temperature are the steam flow and steam temperature in the boiler lead.

Two desuperheater pumps, Fig. 8, furnish turbine condensate through a diaphragm motor operated control valve to the desuperheater on each of the three new low pressure units. When the demand for condensate falls off the condensate automatically recirculates from the desuperheater pump discharge header. Each desuperheater pump has a capacity of 225 gpm at 375 psig discharge pressure.

It will be possible in the future, by the addition of a small amount of equipment, to control the temperature of the steam by tilting the pulverized coal burners automatically.

Electrical Interlocking System

The forced draft, induced draft, primary air and fuel supply interlock so that the following operation results:

a.—Failure of both induced draft fans stops both forced draft fans and leaves all dampers and vanes wide open. Failure of one induced draft fan results in the closing of its inlet louver and the stopping of its paired forced draft fan and the closing of its inlet vanes. The remaining pair of fans then automatically adjust so that they can carry their maximum percentage of the steam generator rating, and the fuel feeding rate automatically reduces to match this percentage.

b.—For pulverized coal firing, failure of any one of the 12 coal feeder motors automatically interrupts the power supply to a group of two feeders in which the defective feeder belongs. Failure of one of the primary air fans results in the closing of its outlet louver damper and shuts down two groups of coal feeders. Failure of both primary air fans and all coal feeders shut down. The automatic combustion control equipment, in case of one fan failing, automatically makes adjustments for the reduced firing rate to maintain safe and efficient combustion.

c.—For blast furnace gas firing, failure of the fuel supply produces a tight closing of all gas flow control valves and the closing of an annunciator circuit. Low pressure alarm switches are provided and may be set at a predetermined low pressure.

d.—Failure of coke oven gas, as indicated by predetermined pressure in the burner supply lines, automatically shuts off the fuel and closes an annunciator circuit.

e.—For all fuels, failure of both forced draft fans results in the shutting down of all fuel feeds, only one induced draft fan, and both primary air fans if they are operating. Failure of one forced draft fan causes its inlet vanes to close and its paired induced draft fan to shut down and close its inlet louver damper.

f.—The starting procedure follows: Either one or both of the induced draft fans must be running to permit the starting of their paired forced draft fans. After which time, for pulverized coal firing, the primary air fans are started and subsequently after a 15second time delay the coal feeders are started up in groups of two. When burning blast furnace gas, the fuel control valves are opened after the forced and induced draft fans are operating.

g.—Primary air butterfly valves are paired with coal feeders so that the butterfly valve can open only when the paired feeder is running, and the valve will remain open for 15 seconds after the coal feeder is shut down.

ut down.

Unit No. 2 and Unit No. 4 have a common control room, Fig. 7, as will Unit No. 6 and Unit No. 8. The boiler instruments, remote control switches and combustion controls are located on a vertical and a desk type panel. The control room, Fig. 7, is enclosed and is pro-

Control Room

vided with filtered air—future air conditioned. Lighting is fluorescent behind eggcrate ceiling.

The control room also contains an intercommunication system which enables the control room operator to speak with operators at various elevations and positions surrounding units No. 2 and No. 4.

The majority of control lines to and from the control room are carried in Armortube, groups of 6, 8 and 12 lines within a protective, flexible steel covering.

Water Level Control

Unit No. 2 has two separate feeds, each with a control valve operated by a three-element control system. Both feeds come off a 12-in. loop header system which serves all of the low pressure units. The boiler feed water control elements are boiler drum level (two elements), steam flow from boiler (common to both), and feed water flow to boiler (two elements). Water input is maintained in proportion to steam output and holds the level within plus or minus ³/₄ inches of desired normal level.

Chemical Feed

One duplex chemical feed pump feeds sodium metaphosphate or sodium nitrate directly to the boiler drums. The pump handles 0–20.8 gph at a discharge pressure of 500 psig and is driven by a totally enclosed constant speed motor. The pump measuring cylinders, displacement plungers, and so forth, are constructed of stainless steel. A 125-gal chemical solution tank now has a dual propeller agitator for mixing chemicals and employs an automatic intermittent feed control system with adjustable feeding and flushing periods. A copper cooling coil permits cooling the deaerated water used in flushing. Eventually, each steam generating unit will have its own chemical feed pump and a common pump suction will be taken from two chemical solution tanks.

Bearing Cooling

Two bearing cooling water pumps supply cooling water to the fan bearings, ash conveyors and sample coolers for the complete plant. These pumps have a capacity of 500 gpm at 300 ft discharge pressure and act as emergency fire pumps.

Ash Hopper and Screw Conveyor

Steam generating unit No. 2 has a unique refractory lined ash hopper. In it a water cooled screw conveyor, protected from direct furnace radiation by a refractory shield, carries ash from the ash hopper to a crusher immediately adjacent. The ash crusher then discharges the ash into a pneumatic conveying system. It was decided to use this type of ash hopper and screw conveyor because the existing units are of the same type, and have proved very satisfactory with very low maintenance costs. Parts are interchangeable on all units; therefore, a minimum amount of spare parts need be kept on hand.

Nitrogen Purging System

Inasmuch as nitrogen is a by-product at the Rouge Plant, it was decided to use this medium for purging the blast furnace gas lines in the boiler house. Purging of these lines is not only necessary for maintenance purposes, but occasionally a flash-back occurs in one of the blast furnace gas headers and must be snuffed out before any great damage occurs. For this reason, a push button panel located near the main exit from the boiler house makes it possible to operate from this one point any of the solenoid valves required to purge any desired branch or header.

Five bottles, each containing 300 cu ft of nitrogen at high pressure, are racked and manifolded into a header. From this header the pressure is reduced to 15 psig in two stages. A three-way solenoid valve feeds nitrogen through a water loop seal into a branch from the main blast furnace gas. Each branch (two per steam generating unit) has its individual rack of nitrogen bottles, pressure reducing station, solenoid valve and water seal. In addition, the 15 psig nitrogen headers tie together and feed a solenoid valve on each blast furnace gas main as they enter the boiler house. For maintenance in the furnace or in the gas headers from the mains, special blanking plates are provided and are inserted on the boiler side of the 36-in. butterfly control valves adjacent to each main. Then, these lines are purged with nitrogen before maintenance is begun. Water entering the loop seals discharges through the three-way solenoid valves to the drain. When a solenoid valve is energized, its corresponding loop seal is blown out by the nitrogen. After a solenoid is energized it must be reset manually. In the case of lack of nitrogen, water or steam can be used for manually purging the blast furnace gas mains.

In addition to purging of blast furnace gas lines, provision is made to purge the coke oven gas mains.

Structural Problems

Installing a 600,000 lb per hr steam generating unit, along with dust collectors, in the place originally occupied by a 200,000 lb per hr unit, presented numerous structural problems. Loading of the existing building columns had to be kept within safe design limits and still keep foundation loading below the maximum allowable. The existing foundation, fortunately, was a continuous mat having an approximate thickness of 9 ft, supported on ample piling. Equipment selection not only involved cost as a major item but also overall weight.

To keep loading to a minimum it was decided to enclose the induced draft fans with corrugated siding rather than extend the masonry building walls. This enclosure is equipped with adjustable louvres for ventilation purposes.

It was necessary to revise the existing pulverized coal bunkers to maintain proper equipment clearances. It also was necessary to provide small compartments in the sides of the bunkers so that the retractable soot blowers can be properly operated.

A dividing plate was added to separate the pulverized coal for unit No. 1 from that for unit No. 2. Chutes were added so that pulverized coal can be fed from either existing screw conveyor above the bunkers to either side of the divided bunker. The gunite lining was replaced on the revised coal bunkers.

It was necessary to add wind bracing between the building columns, which are also used as boiler columns. It was also necessary to replace the main bunker girders. All structural changes and additions were accomplished while the adjacent units remained in operation.

Any modernization program that requires revamping or replacement without a break in production puts a heavy stress on ingenuity and resourcefulness.

The forced draft, induced draft, and primary air fan drives are all 2300-v, 3 phase, 60 cycle, squirrel cage, constant speed motors having class B insulation. These units have across-the-line starters in the new 2300-v metal enclosed switchgear having removable type air circuit breakers.

The coal feeders have 250-v d-c adjustable speed motors, controlled from a new 250-v d-c circuit breaker and starter compartment.

All other drives are 440-v, 3 phase, 60 cycle motors, controlled from centralized motor control centers.

The equipment table below indicates more of the details of operating requirements for individual larger electrical motors such as constant speed, variable or adjustable speed throughout the boiler plant.

The replacement of the low pressure steam generating units (described above), along with the addition of dust collectors to all units, the new ash handling system, and the new water treatment system for the low pressure units are all included in the present expansion program to modernize the power plant. This expansion, when finished, will complete another chapter in the epic story of the Rouge Power Plant, which until recently was the largest industrial power plant in the world and is certainly the most famous.

Editor's Note: A most comprehensive set of controls was furnished on the vertical and desk type panels shown in Fig. 7. The exact nature and a full listing of the individual instruments were given but for space reasons they are not presented here.

PRINCIPAL EQUIPMENT LIST

MODERNIZATION OF POWER HOUSE NO. 1, ROUGE PLANT, FORD MOTOR COMPANY, DEARBORN, MICHIGAN

STEAM GENERATING UNITS

Burners.

Combustion Engineering, Inc.

12 tilting type, pulverized coal burners, 8 blast furnace gas burners, 16 coke oven gas burners, 8 oil burners, all tangentially arranged, per unit, in four corners, complete with hand-operated air-regulators.

Forced Draft Fan, 2 per unit.

American Blower Corporation 96,000 cfm each, 9.1-in. wg., 100 F, \$486, double inlet, double width, inlet vane control, 1175 rpm; 200 hp, 2300-v, 3 phase, 60 cycles, constant speed squirrel cage motor.

Induced Draft Fan, 2 per unit.

American Blower Corporation 258,000 cfm each, 10.0-in. wg., 475 F, \$735, double inlet, 47, double width, Sirocco, inlet louver control, 586 rpm; 700 hp, 2300-v, 3 phase, 60 cycle, constant speed, squirrel cage motor.

Diamond Power Specialty Comp.

Soot Blowers, per unit.

Diamond Power Specialty Corporation

Air-operated, sequential from control room, steam blowing, 6 IK, retractable, 8-2-in. G9B Dialoy units, 8-2-ia. G9B calorized units, for bodler and superheater, 8-2-in. G6B steel units for economizer; 20 short retracting units for furnace walls.

Ductwork and Steel Casing.

Ash Hopper and Screw Conveyor.

Setting and Insulation (with erection).

Setting and Insulation (with erection).

Electrical Switchgear.

Combustion Engineering, Inc.

Setting and Insulation (with erection).

Lectric Company

Belectric Company

Motor Starters, 12.

Electric Controller Company

Auxiliary Relay Panel, 1

Desuperheater Pump Recirculating System. Bailey Meter Company

Smoke Density Recorder, 1 per unit

Bailey Meter Company

Steam Pressure and Temperature Recorder

Bailey Meter Company

Steam Pressure and Temperature Recorder Bailey Meter Company

Steam Pressure and Temperature Recorder Bailey Meter Company

Flow Meters.

Bailey Meter Company

Steam Pressure and Control Bailey Meter Company

Flow Heters.

Bailey Meter Company

Boiler Instrument Panels

Bailey Meter Company

Boiler Company

Boiler Ins

motor. hemical Feed Pumps and Tank, 6 and 2. Milton Roy Company Duplex, each cylinder 20.8 gph maximum, sodium metaphosphate and sod

*Pressure Switches

Crane Company
I. Burack, Inc.
Harry W. Taylor Co.
Revere Copper & Brass Co.
W. T. Andrew Co.
Taylor Supply Co.
R. L. Deppmann Co.
Mercoid Corporation
Combustion Ragineering, Inc.
Hartford Steam Boiler & Ins. Co.
Industrial X-Ray Inc.
The Kuljian Corporation
Cuyahosa Wrecking Co.
Darin and Armstrong, Inc.
Van-Truer Co., Inc.
Schreiber Roofing Co.
Allied Steel and Conveyors, Inc.
Harlan Blectric Co.
Armstrong Cork Co. *Gas Welding ...

*Welding Inspection (Boiler)

*Radiographic Examination (Pipe Welds)

*Recetion of Steam Generating Unit.

*Demolition and Removal Existing Unit.

*Demolition and Removal Existing Unit.

*Rigging Boiler Parts

*Fresh Air Duets (Sheet Metal Work)

*Roofing and Sheet Metal Work

*Miscellaneous Iron Work

*Guniting Coal Bunkers

Electrical Installation

*Piping Insulation. **Spring Installation.

**Corrugated Siding and Louvres.

**Filtered Air System (Control Room).

Metal and Glass Partitions (Control Room).

**Structural Steel (Fabrication). Armstrong Cork Co. W. Biddle Walker Co.

Spitaley-Retemier Sheet Metal Co. E. F. Hauserman Co. Max Corchin & Sons Combustion Engineering, Inc. Max Corchin & Sons *Bunker Steel (Fabricati

*Structural Steel and Bunker Steel (Erection).

All Maninum Ceiling Panels (Control Room).

*Paint. The Kuljian Corporation B. H. Cantile Sales Co. Durako Paint & Color Co. K. I. du Pout de Nemour, Inc. Alchrome Paint Products The Kuljian Corporation Engineers and Constructors

^{*} Refers to Unit No. 2 only-suppliers or contractors.

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METERING TYPE
PACKAGED CONTROL
by HAYS



Now available for all makes and sizes of water tube type package boilers is the new all-electric, metering type Hays packaged control.

Metering type control provides maximum combustion efficiency regardless of the fuel burned because it actually meters the fuel flow and air flow, and automatically maintains the desired ratio. No adjustments are needed when changing fuels or oil burner tips.

All-electric operation includes not only safety devices but also steam, fuel, and air controllers and valves—uses only the normal source of AC voltage. No compressed air is required.

Fully automatic, safe and reliable operation is assured because Hays maintains the same industrial quality built into the largest utility combustion control system and it is factory tested before shipment.

Complete package in one simple and inexpensive to install panel board.

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MICHIGAN CITY, 1, INDIANA

August 1954-COMBUSTION

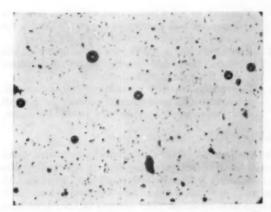


Fig. 1— Photomicrograph of sample of pulverized coal fly ash chosen as standard

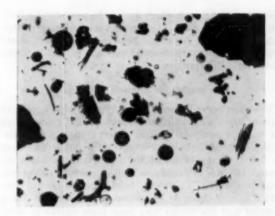


Fig. 2—Photomicrograph of fly ash from spreader-stokarfired boiler furnace

A Comparison of Size-Consist Determinations of Duplicate Samples of Fly Ash

By W. C. HOLTON AND DANA F. REYNOLDS, JR.

Battelle Memorial Institute

Size-consist determinations were made by four independent laboratories on a total of eight duplicate samples of fly ash and the results were compared. This comparison showed that the maximum deviation from the average of the percentage undersize for the two samples analyzed by each laboratory was usually less than 10 percentage points. The terminal velocities calculated from the data reported showed a difference of about 25 percentage points between the limits in the amounts of material settled at any given terminal velocity. The variation in particle sizes was of the same order. It would be expected that the correlation of results obtained in a single laboratory, or those found by different laboratories analyzing duplicate samples, would be better than was reported. The lack of agreement indicates both the difficulty of the analytical methods and the need for better instrumentation in this field.

THE accurate determination of the size consist of dust containing small particles has long been of considerable importance in many industries. Increased concern about air pollution, with a resulting stressing of the importance of removing fly ash from flue gases, has caused engineers responsible for the generation of steam

and for the design of equipment used in power generation to devote more attention to the physics of small particles. The growth in the use of pulverized-coal-fired and spreader-stoker-fired plants has complicated the problem of collecting particles of fly ash in the subsieve range. The techniques developed by metallurgists and others concerned with the determination of the size consist of extremely fine dusts and powders have thus been studied by engineers in the power field in an attempt to provide better equipment for the control of air pollution.

The many recent advances in the design of dust collectors have improved efficiency almost to the maximum for the collection of particles larger than 44 microns (325 mesh). With the attainment of this goal, more attention has been focused upon the improvement of collection efficiency for particles of smaller size. This problem has also been of importance because the use of more suspension-burning devices and of lower grade coals of finer size consist has produced flue dusts containing greater percentages of subsieve material than previously.

As more determinations were made of the size consist of fine particles of fly ash, some of the inherent difficulties of the common methods were discovered. Variations in reported size consists of fly ash from various types of combustion equipment caused concern on the part of those engineers responsible for the design and the operation of dust collectors. In an attempt to develop a common understanding of the problems involved and the techniques being used for the determination of subsieve size consist, Bituminous Coal Research, Inc., sponsored two meetings of representatives of dust-collector manufacturers early in 1951. Recognizing the basic problem of the accurate determination of size consist of small particles, these representatives agreed to analyze dupli-

cate samples of fly ash which were to be provided by Battelle on behalf of BCR. Companies participating in this program were the American Blower Corporation, Prat-Daniel Corporation, Research Corporation, and Western Precipitation Corporation.

Techniques for Subsieve Analysis

No report covering work of this type could be complete without the inclusion of some background material on the various methods used in determining size consist. Each of the methods used requires a lengthy discussion for full coverage of all of the important variables involved, but this material has been presented in the technical literature. Therefore, brief discussions are presented here of the more important methods in use today in order that the reader may keep these details in mind when evaluating the results reported.

The authors have not had first-hand experience with all of the methods described here; hence, the discussions may reflect this lack of familiarity. Inasmuch as the experience of the writers has been limited to a few devices, no one of the methods described can be recommended. The need for an evaluation of existing methods is discussed later in this paper.

SEDIMENTATION

Of all the available methods for determining size consist of small particles, sedimentation is one of the most basic. In theory, the process is much simpler than others reported here. The determination of size consist by sedimentation requires first the choice of a liquid that will completely disperse the particles. Inasmuch as the method requires that each particle settle in the dispersing liquid independently of all other particles, it is important that no particles agglomerate. It is also important that each particle be thoroughly wetted over its entire surface, both external and internal (in the case of cenospheres), in order that the effect of minute air bubbles be eliminated.

The apparent specific gravity of the fly ash and the true specific gravity of the dispersing liquid must be determined accurately. Here again, for the fly ash, the factor of complete wetting of the external surface is important for accurate determinations.

After the dispersing liquid is chosen and the specific gravities of the liquid and the fly ash have been determined, the experimental technique is relatively simple. Although various types of apparatus are used for the determinations, the basic problem is that of measuring the time required for a sample to settle a known distance in the liquid. Stokes' Law related the settling velocity to the specific gravity of the particles and to that of the liquid, to the viscosity of the liquid, and to the equivalent diameter of the particle. Knowing the settling velocity, the equivalent particle diameter can be calculated.

Sedimentation analyses usually report size consists in a relatively wide band. It is common to report the results of such analyses as percentages in the ranges of 0 to 10, 10 to 20, and 20 to 44 microns. Obtaining small variations in equivalent sizes requires relatively little time, however. The accuracy of the determinations will increase as the number of times that a given sample is allowed to settle in the dispersing liquid.

Thus, it can be seen that the determination of size consist by sedimentation, though convenient, suffers from the following disadvantages:

- Necessity to use a liquid that will effect complete dispersion and wetting of the entire sample for accurate determination of size consist.
- Results are commonly reported in rather large size ranges, but could be reported in small ranges with little extra effort.
- Convection currents caused by temperature differences and turbulence introduced as a result of improper technique can result in errors.

AIR-ELUTRIATION DEVICES

An example of an air-elutriation device is the Roller Analyzer. In operation, a sample of fly ash (about 15 cu cm in volume) is accurately weighed and placed in a Utube which is connected to an air source and to a mechanical-type dust collector. The velocity of the air blowing through the U-tube and over the sample is first set for the lowest value desired; i.e., that velocity that will float off the dust of the smallest size fraction which is to be measured. This air stream is passed over the sample, which is mechanically agitated in the U-tube, for a given period of time (usually 30 min), after which the elutriated sample is removed from the collector and weighed. The procedure is then repeated using a higher velocity corresponding to the settling velocity of the next larger fraction desired. The blowing cycle and the removal of the collected sample are both repeated until nearly all the sample has been blown out of the U-tube.

The advantages of the Roller Analyzer are, first, simplicity of operation, and, second, the ease with which size consists in a band as narrow as 5 microns can be obtained. The following disadvantages of the device must be noted, however:

- Necessity of cleaning the apparatus thoroughly after each blowing cycle to remove and weigh the extremely fine particles of dust.
- 2. Each size fraction requires 30 minutes to analyze.

Another elutriation device is the Infrasizer, which was originally developed for the determination of size consist in metallurgical testing. It has since been applied to the analysis of particles of many types, and has been used successfully for the determination of size consist of fly ash.

To quote the manufacturer's catalogue, "The Infrasizer is a laboratory batch instrument for splitting subsieve size powders into seven products, graded according to the settling rate of the particles in air. This is accomplished in six cones in series through which air is passed at an accurately controlled rate. The sample is placed in the first (smallest diameter) cone. The top of this is connected with the bottom of the next by rubber tubing, and so on from cone to cone. The cones are made of hard stainless steel, and the diameters at the top vary as the square root of two."

In operation, the sample is first dried thoroughly in an oven and weighed. The filter bag through which the air escapes from the last (and largest) cone is also weighed before the test. As noted above, the sample is then placed in the first (smallest cone). A constant flow of dried air is maintained through the Infrasizer for the desired length of time. The time factor is important; too little time will not allow a good separation of the sample, but, on the other hand, the separation will not be theoretically complete in any finite time. As a compromise, a period of one hour is usually chosen. At the end of the test, the

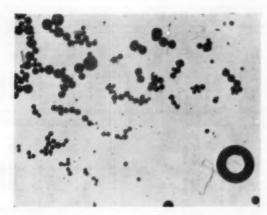


Fig. 3—Photomicrograph of hollow spherical particles of fly ash from standard sample

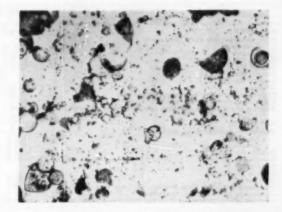


Fig. 4—Photomicrograph of crushed hollow spherical particles of fly ash from standard sample

product in each cone and filter bag is weighed. The size consist of the particles in each of the products must be determined by microscopic count. The average micron size of the particles in each of the seven products, together with the weight percentage of the material collected in each of the cones, then gives the size consist of the sample.

The Infrasizer is not designed for, and hence will not give, a sharp size separation. For example, assume that the average size of the product from the sixth cone was 20 microns. Both the fifth cone and the filter bag would also contain some 20-micron material. This overlapping of sizes is not serious for the usual application of the Infrasizer to metallurgical work, but limits the use of the instrument for very accurate size-consist determinations.

CENTRIFUGAL CLASSIFIER

This device is relatively new in this country, having been first introduced in Sweden. The operation of the machine is described in the catalogs of one manufacturer, but no references have been found in the technical literature that evaluate the performance of the machine.

One classifier of this type operates as a combination centrifuge and air elutriator. The velocity of air through the machine can be adjusted by the insertion of various spacers. In operation, the entire sample is introduced into the center of the machine and to the outside of the spinning disk which is the major part of the machine. The air-flow direction is then reversed by 180 degrees. Only the particles having a terminal velocity equal to or less than the velocity around this turn can follow the air stream and be collected in the pan on top of the disk. Having determined the weight of the sample in this first size range, the remainder of the sample is put through the machine at a lower velocity. This lower velocity is obtained by replacing a small spacer element. The process of running a sample through the machine can be repeated up to eight times, each time with a different velocity, to obtain a complete size-consist determination.

It is obvious that this apparatus is a secondary standard, and must be calibrated against a primary standard (usually sedimentation analysis). The manufacturers advertise that, once calibrated with a sedimentation analysis, the reproducibility is excellent. Obviously, the calibration can be construed as being one of the weaknesses of the apparatus, in view of the difficulties in ob-

taining reasonably accurate sedimentation analysis data.

The chief advantage of a classifier of this type is that it does not require a skilled operator and gives a complete analysis of eight fractions in about two hours.

MICROSCOPIC COUNT

One verification of the size consist of a sample as determined by any of the means described previously can be obtained from a microscopic count. It is significant that none of the samples analyzed in this work were so counted. Yet this system is really a primary standard.

A microscopic count is performed by placing a sample on a microscope slide and actually measuring the size of the individual particles with a cross-hair and vernier attachment. A modification of the system is to project the field upon a screen so that the particles are enlarged to a greater magnification for more ease in counting.

The time required for performing a microscopic count is the chief drawback to a more extensive use of the procedure. Most commercial laboratories feel that the greater accuracy which can be obtained through the microscopic count is not warranted by the time required. It is unfortunate that no comparison between the results here reported and a microscopic count can be made to obtain a more thorough evaluation of these methods.

A serious disadvantage of this system is that only a plan view of each particle is obtained. Both the drag and mass of the particle calculated from dimensions obtained from a plan view can be seriously in error if the particle has an odd shape.

Another factor is that specific gravity must be measured to make the microscopic count results useful. This requires the choice of a dispersing liquid that wets all the surfaces of all of the particles.

Selection of Samples of Fly Ash

The main criteria for the choice of fly ash to be used as a standard would logically be first, an unlimited supply, and second, relatively uniform size consist over a period of time. Pulverized-coal fly ash taken from the electrostatic precipitators at one of the Detroit Edison Company's power plants would naturally meet the first requirement. Material from this source has also been reported to maintain a uniform size consist.

Yellott, J. I., Broadley, P. R., and Buckley, F. D., "The Coal-Burning Gas Turbine," Proc. Midwest Power Conference, 1951, pp 103-120.

Laboratory			-	-A	_				_					-B			-		_
Equivalent particle diam, microns Less than	36)	20		44				7.5		10	15 10	20 15	3 2	n	40 30	,	50 10	
Greater than Sample No. 1 Sample No. 2	5: 5:	6.6	10 15 17	6	20 20 6 21 5	5	9.2 10.7				7.5	10	15	2	D	30		10	60
Sample No. 0 Sample No. 10									32 0 30 0		6.4 7.1 6.7	12.4 15.6 14.0	8.4 7.1 7.7 9.1	1:	2.9 6.4 4.7 2.2	10.6		8.7 9.5 9.1 4.4	5.8 7.2 19.4
Average Maximum deviation from average, per cent Equivalent particle diam, microns	4	2.8	36 30 68	5	21.2 2.8 44		8.0		32 0 30 0 31 0 3 2 7 5		6.7 6.0 10 17.7	14.0 11.4 15 51.7	7.7 9.1 20 59.4	1: 3: 7:	2.2	9.6 11.4 40 83.7		9.1 4.4 50 12.8	19.4
Amount of sample smaller than specified diam, per cent Laboratory	53	2.8	68.	8	90.0				31.0	-	37.7	51.7	59,4	7	6.1	83.7 D	1	12.8	
Equivalent particle diam, microns						-					-					D			
Less than Greater than	3.		6 3	6		5.	6	31 15 21 20	5 2	31	.5		5		10		20 10		20
Sample No. 5 Sample No. 6	4	5	11	.0	3	3.	5 2	21 20	8	81 29 30	8 0								
Sample No. 7 Sample No. 8													30. 35. 32. 7	3	24 20 22	7	20 20	6	24 .5 23 .4 23 .9 2 .5
Average Maximum deviation from average, per cent	7.3	0	11.	3		0.1	9	21	.0	29	3		32.	9	- 8	.4	1	8	23.9
Equivalent particle diam, microns Amount of sample smaller than specified diam, per cent	4	3	15	8	1	5.	1	1 31 70	.1				32.	7	10 55	.3	20 76	1	

Fig. 1 is a photomicrograph (magnification 40×) of a sample of the Detroit Edison fly ash which was chosen as a standard.

Fig. 3 shows some of the lighter material contained in this fly ash, which was segregated by floating on acetone. This photomicrograph was also taken at a magnification of 40×. It is evident from this picture that the light particles which floated on the acetone are spherical.

Fig. 4 is another photomicrograph, at 100×, showing particles of fly ash which were deliberately crushed to show that the particles were hollow and could thus be accurately called cenospheres. Both Figs. 3 and 4 illustrate graphically the importance of wetting the inside surface of the particles, in the case of cenospheres, in order to obtain accurate determinations of both specific gravity and size analysis.

Fig. 2 presents, for comparison with the above three figures, a photomicrograph (at 40×) of fly ash from a spreader-stoker-fired installation. The comparison of this sample with the photomicrographs of the pulverized-coal fly ash is of interest because of the importance of proper installation of dust collectors on spreader-stoker-fired boiler furnaces.

A total sample of approximately 400 lb was obtained from the Detroit Edison Company, through the courtesy of W. A. Carter, for the selection of duplicate samples for this work. This sample was placed in a barrel which was tumbled and rolled to obtain thorough mixing. Eight one-quart cans were filled from the top four inches of fly ash in the barrel. Two cans were sent to the laboratories of each of the four dust-collector manufacturers participating in this program.

Results of Size-Consist Determinations

Table 1 presents the size-consist data reported by each of the four participating laboratories. These data are presented in this form chiefly to show the agreement obtained between the size consists of the two samples furnished each laboratory. Table 1 shows the maximum deviation from the average percentage undersize for each pair of samples. The fact that this maximum deviation is less than 10 per cent for most samples indicates either that the samples were good duplicates or that the techniques used yield moderately reproducible results.

Fig. 5 is a plot of the equivalent particle diameters as a function of the average percentage undersize, the data being taken from Table 1. This figure shows that the

data as reported show a spread of some 25 percentage points. This is not too surprising when it is considered that the data as plotted were obtained using dispersing liquids of different specific gravity and were based on different determinations of the specific gravity of the fly ash. Fig. 5 illustrates the importance of making comparisons of this type only when all data are adjusted to a common denominator.

In order to adjust these data, it is necessary to refer to Stokes' Law, which is usually written as

$$V = \frac{2 g r^2 (d_p - d_1)}{9 n}$$

in which

V = terminal velocity, cm per sec,

g = gravitational constant, cm per sec²,

r = equivalent radius of particle, cm,

 d_p = density of particle, g per ml,

 d_1 = density of dispersing liquid, g per ml,

n = viscosity of dispersing liquid, poises.

The problem of adjusting reported data is simply that of calculating the size of particle that will have the same terminal velocity as that of a particle of a different density. For particles with the same terminal velocity in a given dispersing medium, it will be seen that

$$r = \frac{1}{p} \frac{1}{(d_p - d_1)^{1/2}}$$

Assigning the following additional subscripts,

t = values based on true specific gravity,

a = values based on assumed specific gravity,

the above proportionality may be expressed as follows:

$$r_i(d_{pi}-d_1)^1/2=r_e(d_{pe}-d_1)^1/2.$$

From this,

$$r_a = r_t \left(\frac{d_{pt} - d_1}{d_{pa} - d_1} \right)^{1/2}$$

Table 2 shows the specific gravity data reported by each of the laboratories for both the fly ash and the dispersing liquids used. It is interesting to note that the fly-ash specific gravity determinations varied from 2.1 to 2.378. Equivalent particle diameters were arbitrarily adjusted to a specific gravity of 2.0. The adjusted particle diameters reported in Table 2 were obtained by using

TABLE 2.—SUMMARY OF SPECIFIC GRAVITY DETERMINATIONS AND PARTICLE DIAMETERS ADJUSTED TO SPECIFIC GRAVITY OF 2.0

Laboratory			—B—				D
Sample No.	1	2	3, 4	5	6	7	8
Specific gravity reported: Fly ash Liquid Equivalent particle diam, microns	2 . 36 0 . 80 10 20 44	2.33 0.80 10 20 44	2.1 7.5 10 15 20 30 40 60	2.24 * 3.6 6.4 15.3 31.5	2 22 3 6 6 4 15 3 31 5	2.367 0.821 5 10 20	2.378 0.821 5 10 20
Factor to adjust particle diam to common specific gravity Adjusted particle diam, microns	1.140 11.4 22.8 50.2	$\begin{array}{c} 1.128 \\ 11.3 \\ 22.6 \\ 49.6 \end{array}$	60 1.118 8.4 11.2 16.8 22.4 33.5	1.059 3.8 6.7 16.2 33.3	1.052 3.8 6.7 16.1 33.2	1.145 5.7 11.5 22.9	1.150 5.8 11.5 23.0
Average adjusted particle diam, microns	11 22 49	-3 -7 -9	67 0 8 4 11 2 16 8 22 4 33 5	3 6 16 33	.7	5 11 23	
* (Air used)			44.6 67.0				

the formula above. Inasmuch as the size consists as determined by screening would not be affected by the specific gravity adjustment, these data are not included.

Fig. 6 presents a plot of the average percentage undersize (as reported in Table 1) as a function of the adjusted equivalent particle diameters shown in Table 2. Comparison of Figs. 5 and 6 shows that the effect of adjusting particle diameters was to shift the curves downward while slightly reducing the spread of the points.

Terminal-Velocity Comparisons

Dust-collector manufacturers have long recognized the importance of determining terminal velocities for samples of fly ash. Most persons not closely associated with the field have usually thought of the problem of collecting fly ash from the standpoint of the size of the particles involved rather than the primary variable of terminal velocity. A comparison of the terminal velocities obtained by the laboratories participating in this program is thus in order.

Fig. 7 shows the variation of the amount of fly ash in

suspension at various velocities for three determinations. Data for Fig. 7 were obtained by calculations from test information reported by the manufacturers. The curves for Laboratories C and D, respectively, were computed by an adaptation of the equation for Stokes' Law.

Significance of Comparison of Results Reported

As previously pointed out, the good agreement obtained by each laboratory on the size consists of the two samples analyzed indicates good analytical technique and confirms the validity of the method of obtaining the original duplicate samples. The reproducibility of the results is satisfactory with existing techniques and equipment when used in one laboratory.

The importance of correct specific gravity determinations for both fly ash and liquid has been discussed in this report. This must be stressed, however, because of the difficulty in making these determinations. The choice of a liquid which will effect complete dispersion of the fly ash is often a major problem. For example, in performing sedimentation analyses on a spreader-stoker fly ash

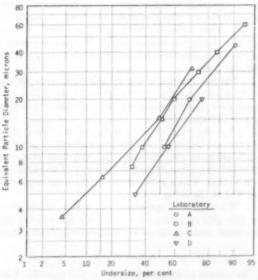


Fig. 5—Average size consists of duplicate samples of fly ash analyzed by four laboratories (from Table I)

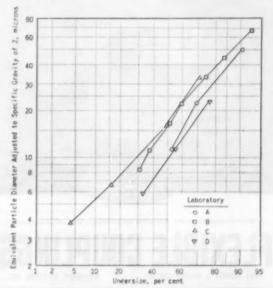


Fig. 6—Average size consists of duplicate samples of fly ash adjusted to common specific gravity

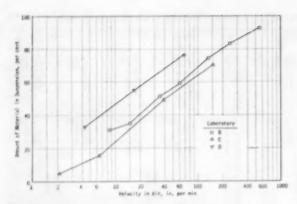


Fig. 7—Percentage of material in suspension as a function of terminal velocity for three analyses

at Battelle (with a different sample than that used in the work here reported), some 40 liquids were tested, none of which was suitable. It is often difficult to determine whether complete wetting of all of the surfaces of the particles is being obtained. Experience at Battelle indicates that no one liquid can be regarded as the universal dispersing agent, but that each sample of fly ash must be tested with a number of liquids in an attempt to find one suitable. Even then there is no assurance that the cenospheres will be filled to result in an accurate analysis.

The difference between the curves of Fig. 6 cannot be

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attributed to variations in specific gravity alone, however. It can be shown that a recalculation of equivalent particle diameter based on the range of specific gravities possible for both fly ash and liquid will shift the size consist plots only slightly. Thus the basic theories of these methods of determining size consist must be re-examined to find an explanation for the wide divergence in results.

Stokes' Law was derived mathematically for solid, spherical particles. In the absence of a more logical assumption, this law has been used without modification for the determination of settling velocity of heterogeneous particles. Laboratory experience has shown that Stokes' Law yields accurate and reproducible results when dealing with solid, spherical particles. Yet fly ash can be considered only a heterogeneous mixture of solid spherical particles, hollow spherical particles, coarse irregularly shaped lace-like particles, broken hollow spheres, and the like. This is well shown in the photomicrograph of Fig. 4.

The most significant observations resulting from this study are probably those connected with the interpretation of Fig. 7. Although the shape of the three curves is the same, the spread between the curves is disturbing. For a given terminal velocity, Fig. 7 shows a difference of about 20 percentage points in the amount of material settled. This would certainly be a significant difference if a collector were being designed on the basis of either of the extremes shown. It would appear that a collector so built would either be underdesigned, and operate inefficiently, or be overdesigned at a needless expense.

It should be pointed out that it is more important to obtain the terminal velocity of particles falling in air, rather than to perform sedimentation determinations in a liquid and convert the results to determine terminal velocity in air. It is evident that much more work needs to be done to find the correct method of determining terminal velocity.

Conclusions

The work reported may be summarized as follows:

1. The maximum deviation from the average of the percentage undersize for the two samples analyzed by each laboratory was generally less than 10 percentage points. This indicates that reproducibility of results within a single laboratory naturally increases with the size consist of the particles, and that laboratory work was carefully done.

 Specific gravity of the fly ash used, as reported by the four laboratories, varies from 2.1 to 2.378. This rather wide spread points out the difficulties in performing this determination.

3. A comparison of terminal velocities calculated from data reported showed a difference of about 25 percentage points between the limits in the amounts of material settled at any given terminal velocity. The variation in particle sizes, which were calculated from terminal velocities, was of the same order.

4. The degree of agreement of the data indicates both the difficulty of performing sub-sieve size-consist determinations and the need for improved instrumentation.

Future Work

The results of this work indicate the need for further study of the problem of obtaining accurate size-consist determinations of fly ash

Case History of an 850-psig Topping Turbine Installation

By H. R. EMERY and P. L. NELSON

St. Regis Paper Co. Chas. T. Main, Inc.

Steam and power generating equipment in many of the older pulp and paper mills in the country is obsolete, inefficient and approaching the end of its useful life. The modernization of a typical old steam power plant at the Deferiet mill of the St. Regis Paper Co. is discussed. The case history covers: (1) the original steam plant and previous changes made in it, (2) engineering studies preceding the actual installation, (3) equipment installed in the new steam power plant, (4) preliminary operating problems encountered, and (5) present-day operating costs of the new power plant.

HE Deferiet, N. Y., mill is the original mill of the St. Regis Paper Co. This mill, completed in 1901, was described in the newspapers of that day as a "gigantic manufacturing institution." Installed equipment included four paper machines with widths varying from 90 to 145 in. The boiler house contained twenty 100-hp Watertown Iron Works boilers grouped in batteries of five and hand fired. Four Watertown Engine Co. 300-hp reciprocating steam engines were installed in the engine room, their power being transmitted by belt and lineshaft to the machines. Three 500-light generating units were installed for electric power, these being driven through a rope drive either by steam engine or water power.

Previous Changes in Steam Power Plant

The mill started up and operated on the above-listed steam and power equipment until 1913 when two 610-hp, 150 psig, Sterling-type, stoker-fired boilers were installed in battery. In 1915 Nos. 3 and 4 boilers were installed, followed by Nos. 5 and 6 in 1921; all were the same size and type of Sterling boiler. Of the 20 original Watertown Iron Works boilers installed in the mill, two are still in operation as bark, sawdust, and trash burners in the small boiler house in the yard. The others were junked or scattered over a considerable portion of the northern New York area for various types of service.

During the years 1924 to 1927 the reciprocating drives on the four paper machines were replaced with individual turbine drives. Boiler Nos. 3, 4, 5 and 6 were redesigned for pulverized coal firing; size F Aero pulverizers were installed on each boiler; and superheaters giving 80 deg F superheat were added. Nos. 1 and 2 were relegated to an emergency standby basis.

In 1925 the Central New York Power Co. installed a 5000-kw condensing turbine-generator in a power-house built on the mill premises adjacent to the boiler house. This was operated by the utilities during times of the year when low river flow limited the power output of their hydroelectric plants. Steam to operate this turbine-generator unit was purchased from St. Regis Paper Co.

No further changes in the steam and power systems were considered until 1936 when, due to the age of the operating boilers, it became apparent that new steam generating equipment would soon be required.

Engineering Studies Previous to 1940

In the years between 1936 and 1939, steam and power surveys were made by several engineering concerns. Four basic recommendations of major surveys for the installation of new steam and power generating equipment are tabulated in Table I.

Although the results of these studies were presented to the management, no action on purchasing new boilers could be taken. One recommendation made as a result of these studies was to purchase the 5000-kw condensing turbine-generator from the Central New York Power Co. This recommendation was followed, and the unit was purchased by the St. Regis Paper Co. in 1936.

In 1939 additional surveys of the steam and power systems resulted in three more basic recommendations. The results of these additional studies are in Table II.

This second set of studies was advanced for the consideration of management, and again no action could be taken on the power expansion program. However, the results of the various surveys have been listed in outline form to show that the management of the mill was continually exposed to the thinking of the consulting engi-

^{*} Presented at the Eighth Engineering Conference of the Technical Association of the Pulp & Paper Association, Montreal, Que., Oct. 20–29, 1953. Abridged from May 1964 issue of TAPPI.

		TABLE I-SUMMAR	OF SURVE	ES MADE IN 1930	
Survey No.	Recommended Boiler	Recommended Turbine generator	Estimated Investment	Gross Yearly Savings	Remarks
1	One 100,000 lb per hr, 500 psig, 750 F	One 3000-kw noncondensing	\$389,000	\$126,000 (32.4%)	Includes electrified paper machine drives
2	One 100,000 lb per hr, 600 psig, 850 F	One 3500-kw noncondensing	\$436,000	\$137,000 (31,4%)	Includes electrified paper machine drives
3	One 100,000 lb per hr, 900 paig, 900 F	One 4000-kw noncondensing	\$501,000	\$158,000 (31.6%)	Includes electrified paper machine drives
4	One 100,000 lb per hr, 1400 psic, 900 F	One 5000-kw noncondensing	\$560,000	\$173,000 (30.9%)	Includes electrified paper machine drives

The above studies were based upon: (a) delivered cost of coal = \$4.60 per ton; (b) average cost of purchased electric power = 0.6¢ per kwhr; (c) number of paper machines at the mill = 4.

TABLE II-SUMMARY OF SURVEYS MADE IN 1939

		TARREST TA TACHEREN	T OF BURKER	I'M DESCRIPTION AND THESE	
Survey No.	Recommended Boiler	Recommended Turbine-generator	Estimated Investment	Gross Yearly Savings	Remarks
1	One 120,000 lb per hr, 900 paig, 825 F	One 5000-kw double extrac- tion, poncondensing	8544,000	8178,000 (32.8%)	New turbine to drive 5000-kw generator purchased from utilities
2	One 120,000 lb per hr. 900 paig, 825 F	One 7500-kw noncondensing (topping)	\$758,000	\$262,000 (34.5%)	Includes electrified paper machine drives
3	One 200,000 lb per hr,	One 5000-kw noncondensing	\$726,000	\$256,000 (35.3%)	Eliminates purchase of electric power

neers, and that the recommendation of the consulting engineers was toward continued higher operating pressures for industrial steam power plants.

In 1940 a fifth paper machine was installed at the mill, and went into service in August of that year.

Studies Immediately Preceding the Installation

In 1940 the consulting engineers from Chas. T. Main, Inc., made their first engineering survey at the Deferiet mill. Their original recommendations, based upon the steam and power requirements of the mill with the five paper machines, were as follows:

- Install two 70,000 lb per hr pulverized-coal-fired boilers to operate at 600 psig, 750 F.
- Install one 3000-kw noncondensing turbine-generator unit to take steam at 600 psig, 750 F at
 the throttle and exhaust at 150 psig to the pulp
 and paper mill and to the existing 5000-kw condensing unit.
- 3. Remove the existing Sterling (Nos. 1, 2, 3 and 4) boilers to make room for the two new boilers.
- Retain the existing Nos. 5 and 6 boilers in service as emergency standby equipment.

The investigated investment required was \$389,000 resulting in a gross yearly saving of \$79,000 (20.3%).

Again economic conditions apparently stopped the management from taking the proposed steps to purchase the new power equipment. The advent of World War II stopped any further moves in this direction for the next 4 years. The State Department of Labor, after proper hydrostatic tests, allowed the six existing Sterling boilers to be operated at design pressure through the war years with the provision that steps would be taken to replace them as soon as materials became available.

In 1944 Westinghouse Electric Corp. made an independent survey of the steam and power needs of the mill, and came up with recommendations that followed very closely those made by Chas. T. Main, Inc., in 1940.

Plans were made in 1944 for increased paper production at the mill. Installation of the No. 6 paper machine was authorized, and the possibility of a seventh machine in the future was considered. Plans also included changed types of paper. Since any study of mill steam and power requirements is no more accurate than the pulp and paper tonnage figures used in making the study, it was necessary to revise the previous power surveys in order to meet the power requirements of the proposed increase in mill output. Consequently Chas. T. Main, Inc., was retained in 1944 to revise their 1940 report to take into account the increase in steam and power requirements. This final report was based upon the following production figures.

Paper production (seven machines)	306	tons	per	day
Groundwood pulp production	150	tons	per	day
Sulfite pulp production	100	tons	per	day
Bleach production	100	tons	per	day

From these production figures the average steam and power requirements were estimated. The estimated power requirements are tabulated in Table III, and the estimated process steam requirements are tabulated in Table IV.

Using these estimated quantities of steam and power, several sizes of equipment and combinations of the sizes were considered. The final choice was made from the four possible schemes of development outlined in Table V.

Scheme four consisting of two 100,000-lb per hr boilers at 800 psig, 825 F. and one 6000-kw noncondensing turbine-generator was the recommendation made by Chas. T. Main, Inc., to the St. Regis Paper Co. as the first step of a long range steam and power expansion program. The full recommendation was to complete the expansion in three steps as follows, the last two steps being deferred into the future.

Step 1—to be done as soon as possible.

- Install two 100,000-lb per hr pulverized-coal-fired boilers to operate at 850 psig, 850 F.
- Install one 6000-kw noncondensing turbine-generator unit to take steam at 800 psig, 825 F at
 the throttle and exhaust at 150 psig to the pulp
 and paper mill and to the existing 5000-kw condensing unit.
- Remove existing Nos. 1, 2, 3 and 4 boilers to make room for the two new boilers.
- Retain the existing Nos. 5 and 6 boilers in service as emergency standby equipment.
- Step 2—to be done when Nos. 5 and 6 boilers are condemned.
- Install a third 100,000-lb per hr boiler similar to the first two installed under step one.
- Remove existing Nos. 5 and 6 boilers to make room for the third 100,000-lb per hr unit.
- Slep 3—to be done if ever justified economically. Based on the economics of future purchased power contracts.
- Install a fourth 100,000-lb per hr boiler similar to the first two installed under step one.
- Install two additional 6000-kw turbine-generators to permit the mill to generate all required electric power.

The definite decision to go ahead with step 1 of the recommended program was made early in 1945, and design of the installation commenced at once. A simplified schematic diagram of the modernized steam power plant is shown in Fig. 1. It has not yet been necessary to proceed with step two or step three of the program.

TABLE III.—ESTIMATED ELECTRIC POWER REQUIREMENTS

Average	Material	Per Unit	Total
Production		Electric Energy,	Electric Energy
Tons per Day		Kwhr per Ton	Kwhr per Day
306	Paper	670	205,000
150	Groundwood pulp	1400	210,000
100	Sulfite pulp	170	17,000
100	Bleach	120	12,000

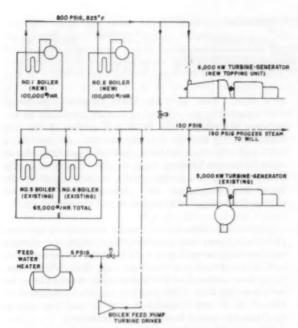


Fig. 1 Schematic diagram of modernized steam plant



In order to present the picture in a readily understandable form, the anticipated steam loads were compared graphically to the recommended boiler capacities. This is indicated in Fig. 2. The steam load curves show:

 The variation in the average steam load during the course of an average year. This curve is labeled "average steam load."

The amount the average steam load may be expected to exceed the monthly average on any given day.
 This curve is labeled "maximum daily average."

 The amount the average steam load may be expected to fall below the monthly average on any given day. This curve is labeled "minimum daily average."

day. This curve is labeled "minimum daily average."

4. The variation in the instantaneous peak steam load during the course of the year. This curve is labeled "anticipated peak."

5. The variation in the instantaneous minimum steam load during the course of the year. This curve is labeled "anticipated minimum."

Bar graphs representing continuous boiler capacities have been included adjacent to the steam load curves to show:

 The 200,000-lb per hr total continuous capacity of the two new boilers exceeds the maximum daily average steam load in the winter by about 14,000 lb per hr, or roughly 7 per cent.:

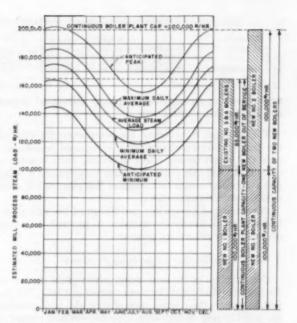


Fig. 2 Comparison of anticipated steam loads and boiler capacities

2. In the summer months with one of the new boilers at a time off the line for the annual inspection and maintenance period, the entire mill steam load can be carried by the remaining new boiler plus Nos. 5 and 6.

The logic of the selection of the two 100,000-lb per hr boilers, whose combined capacities exceed the maximum steam load by a small margin, is evident from this graph. Also the existing Nos. 5 and 6 boilers are available either as standby steam capacity for the new boilers or to produce 150-psig steam for use in the existing 5000-kw condensing turbine if condensing power should ever be required in the winter months.

In selecting the operating pressure and temperature for the new boilers and the kilowatt rating of the new turbine-generator, curves similar to those shown in Fig. 3 were used. These curves represent three of the many possible combinations of steam pressure, steam temperature and turbine-generator size that were studied. In general in installations of this type, as the throttle steam pressure and temperature of the topping unit are increased, it is true that:

1. For any given steam load, more noncondensing power will be produced and a larger turbine-generator will be required. This is evident from the curves of Fig. 3.

The capital investment required will be increased by the need for higher pressure equipment and a larger turbine-generator.

3. The yearly operating costs will be decreased as

TABLE IV-ESTIMATED AVERAGE PROCESS STEAM REQUIREMENTS-DEFERIET MILL

Average Production Tons per Day	Material	Average per Unit Steam Usage, Lb Steam per Ton	Average Total Pr	ocess Steam Load, Lb Steam Summer	per Day Winter
306 100 100	Paper Sulfite pulp Bleach	9000 6000 3000	2,754,000 600,000 300,000	2,400,000 500,000 200,000	3,000,000 700,000 400,000
		Daily total Hourly average	3,654,000 (152,000 lb per br)	3,100,000 (129,000 lb per hr)	4,100,000 (171,000 fb per fr)

Scheme No.	Beilers	Turbine-generator	Estimated Investment	Gross Yearly Savings
1	Two 100,000 lb per hr, 600 psig, 750 F	One 4000-kw noncondensing (topping)	\$850,000	\$120,000 (14.1%)
2	Two 100,000 lb per hr, 600 psig, 750 F	One 5000-kw noncondensing (topping)	\$880,000	\$130,000 (14.8%)
3	Two 100,000 lb per hr, 800 psig, 750 F	One 5009-kw noncondensing (topping)	\$1,000,000	\$154,000 (15.4%)
4 (recommended)	Two 100,000 lb per hr, 800 psig, 825 F	One 6000-kw noncondensing (topping)	\$1,035,000	\$164,000 (15.8%)

noncondensing steam power replaces purchased power and condensing steam power.

The optimum is, of course, the point where the total of the yearly carrying charges on the required investment plus the yearly power plant operating costs reaches a minimum. In this particular case this optimum point was reached at steam conditions of 800 psig, 825 F with a 6000-kw turbine-generator.

Purchasing of equipment and design of the new plant followed immediately the decision to proceed with step one of the recommended program.

Preliminary Operating Problems

Construction of the new steam power plant started in 1945, and operation of the plant started in 1946. For the first two years the regular crew of men who had operated the old 150-psig boilers were apprehensive and unsure of themselves while operating the modern, high-pressure equipment. Continued checking gradually uncovered the causes of the initial operating difficulties. The major troubles encountered were as follows:

 In spite of previous pulverized coal experience in the boiler house, one furnace explosion occurred which required replacement of much of the furnace brickwork.

Water treating problems, with both the automatic controls and the types of treatment, were unsettled for

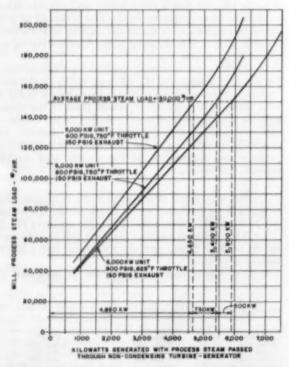


Fig. 3 Relationship of anticipated steam loads to power generation

some time. Even after the water treatment problems were apparently solved, the operators continued to experience blistering of the front wall section of the new boilers directly over the top two burners. At one time a front wall tube ruptured for a length of about 12 in. due to scale formation blowing most of the water out of the boiler, bulging the furnace walls, drowning out an induced draft fan motor, and perhaps one of the worst effects, increasing the apprehension of the operators.

Mechanical failures in the boiler internals of feed and phosphate lines causing uneven distribution of feedwater and chemicals seem now to have been the major contributors to the blistering of the front wall tubes. Acid cleaning at least once a year was necessary in order to keep the boilers on the line. This practice has been continued although it is now considered that it may be safe to lengthen the period between acid treatment.

Water treatment went through several changes and evolved the following present practice:

River water enters chemical treatment at the clarifier where it is coagulated with alum and sodium aluminate. Much of the color and suspended solids are removed by the coagulation. The clear effluent is then filtered by gravity and softened by sodium cycle zeolite. At this point the water is practically at zero hardness, but for high pressure boiler use it must be further treated to prevent corrosive action on boiler system metals. caustic is added to the roof tank storage to maintain feedwater at a high alkaline condition. Roof tank water flows to the condensate tank, where the mixing of the two waters makes up the feedwater for the boilers. The feedwater is pumped to the deaerator where oxygen is removed, then into the heater tank, at which point sodium sulfite is added, to remove the last traces of oxygen. Nalco 75, a lignin derivative compound which

TABLE VI-COST OF STEAM AND POWER—COMPARISON OF OLD

	Total district	- Marianes		
10	Total Steam	Total Electric Energy 1000 Kwhr per Yr		Total Cost \$ per Yr
1945 Boiler House and	Electric Gener	ating Equipm	ient	
Present mill process steam gen- erated with 1945 equipment Purchased electric power	1,179,395	123,935	8	877,200 ,022,394
Total cost of steam and electric pe	wer		81	.899,594
Present Boiler House an		erating Equip		
Present mill process steam Steam to generate electric power	1,179,395 516,332			
Total steam generated Electric power total, purchased and generated (exclusive of steam required)	1,695,727	124,680	81	,047,593 597,037
Total cost of steam and electric power			\$1	,644,630
Annual Saving in 7	Total Steam an	d Power Cost	=	
\$1,899,594 less \$1,644,630			8	254,964
Cost of Steam an	d Power per T	on of Paper		
				a per Ton of Paper
1945 equipment (1,899,594/ 92,900 tons)				\$20,45
Present equipment (1,644,630/92,900 tons)				17,70
Savings per ton of paper				\$ 2.75

prevents scale formation when used in an alkaline medium, is added with the sodium sulfite solution. The last chemical addition to the water takes place in the steam drums of the boilers where sodium phosphate solution is added to remove the last trace of calcium hardness. Internal inspection for the last two years has indicated that this is successful.

Present-day Operating Costs

The total cost of the new steam power plant, plus the cost of improvements and additions to the electrical distribution system not discussed here, was about \$1,900,-000. Comparisons of savings effected by the change are difficult to make due to rapidly changing economic conditions. However, to illustrate the difference between the yearly cost of steam and power using the old equipment available in 1945 and the yearly cost using the present equipment, Table VI has been prepared. The cost figures in Table VI are based upon quantities of steam and electric power used for the year June 1952 to June 1953 plus current labor and fuel rates.

The reference literature, "Selection of Steam Pressures and Temperatures for Paper Mill Power Plants"*, has been used to calculate the over-all thermal efficiency of the new steam power plant. Using Fig. 4 of the reference literature plus the following data gives:

Steam to main condensers... Total boiler steam output... Per cent of total steam output

340,332,000 lb per yr 1,695,727,000 lb per yr

20.1% Power plant thermal efficiency 63%

During the past year an increase in the purchased electric power rate has made the cost of condensing steam power lower than the cost of purchased electric power. As condensing power replaces purchased electric power, the power plant thermal efficiency will, of course, be reduced due to the increased heat loss to the condenser.

Dollars return per year on the new power plant are higher than originally predicted due to the increased cost of purchased electric power since the installation was made. The original savings were based upon a purchased power cost of 0.4 cent per kwhr as compared to a present cost of approximately 0.8 cent per kwhr.

^{*} Dixon, M. H., W. C. Bloomquist and W. B. Wilson, Tappi, Vol. 33, No. 7, ly 1950, pp. 305-312.



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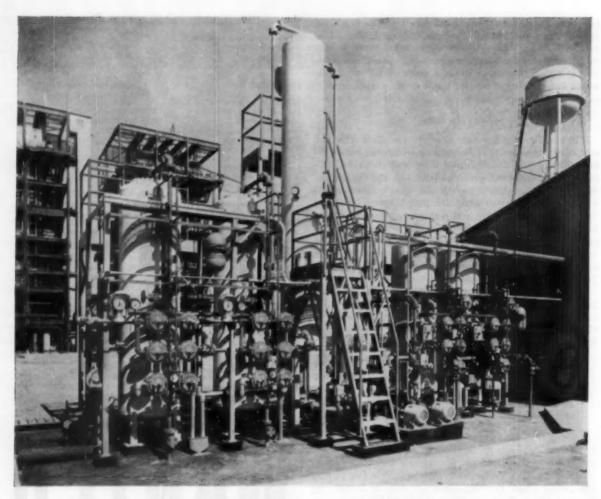


Fig. 1.—Fully automatic 1800 gph two-bed demineralizer vacuum degasifier stands between anion cation units

The Status of Demineralizing In Today's Plants*

The application of demineralization to boiler feedwater treatment has proved sound and economical. This account puts a statistical value on the number of installations to date and supplies helpful curves for estimating costs and performances of the systems now on the market.

LTHOUGH there are many new developments of interest in feedwater treatment for central station plants including improved deaerating heaters, short retention clarification equipment and automation of equipment generally, an interim report on demineralizing warrants attention.

In the last four years a considerable amount of demineralized water has been produced and utilized in central station and industrial power plants throughout the country by the use of multi-bed and mixed bed ionBy V. J. CALISE

Graver Water Conditioning Co.

exchange demineralizers. A consideration of four principal areas points up today's situation and can be of great value in appraising developments in the next few years. These areas are:

 Approximate number, flow and type of demineralizers as compared to evaporators installed in power plants to date.

* Presented before Southeastern Electric Exchange Meeting, Miami—May 7, 1954

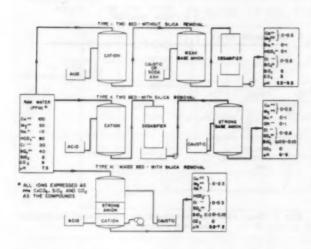
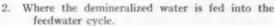


Fig. 2—Basic types of demineralizers, above, include Type I, lowest chemial costs but no silica removal; Type II, as effective as Type I plus silica and carbon dioxide removal; Type III, most complete removal of strong electrolytes, silica removal optional



- 3. Arrangements used for chemical regenerant han-
- Automation of operation, instrumentation and controls.

Number, Flow and Type of Demineralizers

Acid regenerated cation exchangers of the phenolic or coal type became commercially practicable about 1937. Weakly basic anion exchangers and demineralizing, as we know it, were made practicable in 1940. In 1946 strongly basic anion exchangers to reduce silica and CO₂, as well as strong electrolytes, were promoted.

As of the present time approximate industry-wide statistics on ion-exchange plants of various types for feedwater treatment for both industrial power plants and central station utilities follow the breakdown in Table I.

With such data serving as a background we feel a fair presentation of facts would show between one and two demineralizers used for central station high pressure boiler makeup to every four or five evaporators on low makeup units. Where total makeup flow runs substantially above 50–75 gpm demineralizers constitute an even higher percentage relative to evaporators because of generally lower equipment cost advantages, particularly on lower solids water.

Advantages of demineralizers over evaporators that have made them quite popular with utilities are: (1) higher purity of effluent from demineralizer over evaporator, (2) no need for steam bleed for operation of demineralizer, (3) lower operating costs with demineralizer due

Initial distributor and beck-week occase to institle of tentil occase to institle occasional occasional distributor under lining permanently relocated to steed surface occasional occasional

Fig. 3—Cutaway view of a large ion-exchange unit with all parts labeled. Special emphasis is accorded the distribution system to avoid short-circuiting or channeling

to lower chemical costs and less energy degradation, (4) lower equipment costs especially in the higher makeup flows above 50 gpm.

Recent installations of demineralizers indicate the mixed bed type applies wherever higher solids raw waters like those in the Southwest, Far-West and Midwest are encountered. Also where extreme purity of 4,000,000 ohms-cm resistance as well as 0.02 ppm silica is desired, such as with boiler pressures above 2000 psig, the mixed bed type is chosen.

With lower solids waters, such as in the Southeast, however, 2-bed demineralizers or even 4-bed units come into their own. Treated water usually runs 1-2 micromhos purity with less than 0.02 ppm silica with such multi-bed units.

The preservation of optimum long term operating performance on both mixed bed and multi-bed demineralizers involves: (a) selection of proper type of anion exchange resin—Type II resins for waters of high percentage strong acids to weak acids; Type I for waters of high percentage of weak acids (b); supplying a very clear, organic-free water to the demineralizer; (c) proper regeneration conditions; (d) possibly lower oxygen in the water in contact with the anion resins.

Demineralized Water Entrance Into Cycle

Two-bed demineralizers usually employ degasifiers or vacuum deaerators to remove carbon dioxide (see Fig. 2). The forced draft aerator or degasifier saturates the water with oxygen by blowing filtered air through the water. The cold water vacuum deaerator removes both oxygen (down to 0.1 ppm) and carbon dioxide (to less than 1 ppm). Its use is preferred over the degasifier for these reasons:

It removes oxygen from the water as well as carbon dioxide, instead of saturating it with air, and thereby reduces the oxygen load on all other oxygen removing units in the system including turbine condenser and deaerator.

It permits introduction of cold water into the cycle

TABLE I—PRESENT-DAY ESTIMATES OF ION-EXCHANGE UNITS IN CENTRAL STATION AND INDUSTRIAL SERVICE

IN CENTRAL STATION AND INDUSTRIAL	SERVICE
A-Greensand sodium zeolite softeners	10,000-15,000
B-Siliceous sodium zeolite softeners	3,000-5,000
C-Styrene and phenol base resin & coal base sodium	4.000-6.000
zeolite softeners D-Hydrogen cation exchange with sodium zeolite	500- 700
E-Weakly basic anion demineralizers	250- 350
F-Strongly basic anion demineralizers with silica re-	250- 350
duction	250- 350

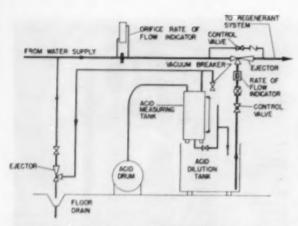


Fig. 4—Typical storage and handling of acid or alkali for larger demineralizing plants

FROM WATER SUPPLY

CONTROL

VENT

PUMP

CONTROL

VALVE

RATE OF

FLOW INDICATOR

PLANE

CONTROL

VALVE

RATE OF

FLOW INDICATOR

VALVE

CONTROL

CO

Fig. 5—Basic acid regenerating system employed for smaller demineralizing plants

and this permits maximum heat efficiency, overall. In some cases the vacuum deaerated water at a pH of 8.0-8.5 from a 2-bed unit can be discharged directly into a turbine condenser or condensate surge tank. With a degasifier delivering water saturated with air some preferential deaeration in a steam pressure deaerating heater followed by cooling is required to remove higher amounts of oxygen. The vacuum deaerator eliminates the cost of such a steam pressure deaerator. This high pH water with less than 0.1 ppm oxygen is also less aggressive to metal and less expensive piping and storage material are generally required.

There is some evidence to indicate that lower oxygen of 0.1 ppm may somewhat increase the long term life and performance of the highly basic anion exchangers used in this process. Since these products run somewhat more expensive than other ion exchangers it is wise to take all precautions to prolong their useful life.

Mixed bed demineralizers produce demineralized water at a pH of 7.0 and vacuum deaeration or steam pressure deaeration is employed to reduce oxygen in this water before feeding into the system. Again the condensate surge tank or the turbine condenser represent the preferred points of demineralized water introduction, depending on such water temperature and other cycle characteristics. In some cases, small amounts of caustic soda are fed into the demineralized stream before the surge tank.

Chemical Regenerant Handling

Absolute dependability of service of all demineralizing equipment with minimum maintenance i volves close attention to design and construction of regeneration equipment as well as valves, controls and instruments. Since handling of quantities of acids and alkalis sometimes on a daily or semi-weekly basis is a necessary part of demineralizer operation, foolproof design and construction of this part of the equipment is necessary.

Figs. 4 and 5 give two typical designs of chemical handling systems. Materials of construction are shown in Table II.

As for determining the estimated chemical operating cost of various demineralizing systems we recommend a six-step procedure. First step involves obtaining an analysis of water to be treated with results expressed in ppm as CaCO₃. The second step tallies from this analysis the total cations in ppm as CaCO₃. This total is the sum of the Ca⁺⁺, Mg⁺⁺ and Na⁺⁺ in ppm as CaCO₃. At the same time steps 3 and 4 are undertaken and the methyl orange alkalinity is obtained in ppm as CaCO₃. This data, in ppm of methyl orange, divided by total cations and multiplied by 100 gives per cent alkalinity, step 4.

A review of the raw water analysis and its proposed use constitutes step 5. This review determines if silica and CO₂ removal need be done. Finally, in step 6, the use of the curve, Fig. 6, produces approximate chemical operating costs in cents per 1000 gal. of net water to service.

There is a slight note of precaution to sound in the use of Fig. 6. You enter the curve along the ordinate with the data on total cations, step 2, above, and move over to the curve indicating alkalinity in per cent as calculated by step 4. But here is the note of caution. Be certain to use the correct series of curves as labeled in Fig. 6. Then drop down from this intersection point of per cent alkalinity with the curve showing total cations to read estimated chemical costs on the abscissa.

Automation of Operation

In general, there has been a greater and greater trend toward complete push button operation and regeneration of demineralizing units. The use of time cycle control mechanisms, such as Bristol Cycle Controllers, together with diaphragm operated rubber lined Saunders Patent

TABLE II-SUITABLE PIPING AND FITTINGS MATERIALS

Point of System	Characteristics Relative to Steel	Materials of Construction
Influent Raw Water	Not usually corrosive	Steel pipe in all sizes
Cation unit effluent	Acid very corrosive	Plastic pipe in smaller sizes; plastic pipe, rubber-lined steel pipe in larger sizes
Anion Unit effluent	Low Solids, oxygen- corrosive	Plastic pipe in smaller sizes; rubber-lined steel pipe; plastic-lined steel pipe in larger sizes
Concentrated H1SOc	Mildly corrosive	Heavy-walled steel pipe
Lilute H ₂ SO ₄	Very corrosive	Plastic pipe in smaller sizes, rubber-lined steel pipe in larger sizes
Concentrated and dilute hydrochloric acid	Very corrosive	Plastic pipe in smaller sizes; rubber-lined steel pipe, plastic pipe in larger sizes
Sodium carbonate	Not corrosive	Steel pipe in all sizes
Sodium hydroxide	Not corrosive	Steel pipe in all sizes

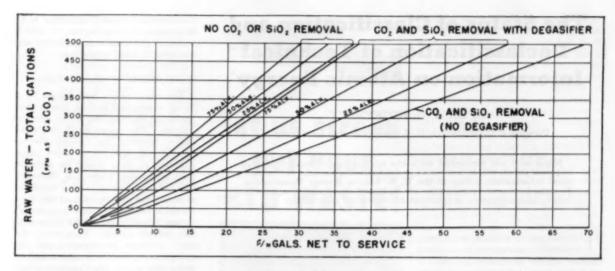


Fig. 6—Estimated chemical operating costs for various demineralizing systems can be picked off the above curves.

The curves have been worked up using average chemical costs as of early 1954

Valves, for absolute drop tightness and lowest maintenance, has been the general rule. Dependability, foolproof service of many years with virtually no maintenance or outage is the reason for this.

Figs. 7 and 8 show typical performance curves from 2bed and mixed bed units.

Primary control of regeneration in all demineralizing plants, generally without exception, comes from use of the substantially foolproof and simple conductivity meter. Wherever water does not meet conductivity standards, the demineralizer must be rinsed to waste for a preset time or regenerated after alarms are sounded.

Totalizing meters on the inlet and outlet from the various ion exchange units, particularly on waters of seasonally constant composition, affords a means of secondary control in many plants.

In some cases pH meters with proper sampling points control endpoints on cation units but this method is not generally applicable for primary control of operation or initiation of regeneration.

Silica tests, generally run gravimetrically, are performed once or twice daily in some power stations for record purposes. In the main, however, silica stays well within the guaranteed limits as long as the conductivity of the treated water is below the required value as per Figs. 7 and 8.

Flow line type lighting on preassembled panel boards

Flow line type lighting on preassembled panel boards has been employed in several utilities, particularly where mixed bed units are employed such as at Shawville Station of Pennsylvania Electric Co. The latest designs of these preassemled panel boards present an attractive addition to the boiler house.

With the above indications of proper instrumentation, reliable automatic operation and push-button panel board assemblies the demineralizing plant has definitely reached a comparable performance level with the other major elements in power plant practice. And in keeping with the experience of these other elements, future progress will result from improvements in the materials involved, as well as from advances in the techniques of application and operation.

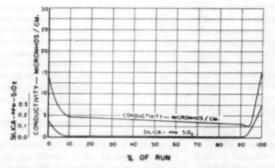


Fig. 7—Two-bed silica removal demineralizing system shows that performance changes sharply as silica breaks through, conductance drops momentarily and then shoots up rapidly as shown

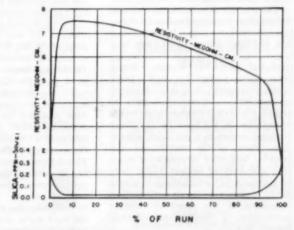


Fig. 8—Mixed bed silica removal demineralizer shows the same general performance characteristics. Electrolyte removal is so complete curve is plotted in terms of resistivity rather than conductivity

The Status of Classification and **Declassification of Technical** Information on Atomic Energy

by DR. J. G. BECKERLEY

Director of Classification, U. S. Atomic Energy Commission

Many who are concerned with the application of nuclear energy to power plants will be interested in the following account of the tech-nical information policy of the U. S. Atomic Energy Commission. Reasons for current restrictions are discussed along with prospects for future declassification of information on reactor technology.

HE decision to withhold publication of technical information is not direct action against unfriendly nations. It is a very limited defensive mechanism. Withholding information does not prevent others from developing the same information by their own efforts. This must be continually borne in mind, Secrecy is a passive technique. Moreover the limitations of the assistance afforded by access to technical information should be understood. A sketch of a plutonium chemical separations process is only a piece of paper; to translate it into an operating plant requires many man-years of effort, perhaps more ingenuity than went into the original process sketch. Information about a device is not the device itself. This is obvious, but often missed in popular discussion. To many persons the phrase "handing out our secrets" implies the furnishing of things, not information; the word "our" in the phrase implies exclusive possessionwe have them, the only secrets in the

I dislike repeating such simple notions but I have observed much confusion where these simple ideas are forgotten,

The practice of withholding technical information from publication or delaying issuance is not new. Information on the technical devices of war has been controlled in proportion to the increasing technical nature of warfare. Nowadays, the time interval is small between a highly technical, "long-hair" discovery or invention and its application to military devices. Fundamental ideas of today may be the basis for significant military devices in a few short years or less. Prior to the mid-thirties this interval was often a decade or more. The discovery of nuclear fission early in 1939 and its battlefield use in a militarily decisive device in mid-1945 is indicative of the speed of military application of fundamental scientific information.

Information Control

Because of this trend toward telescoping basic research and military applications, there has been an increase in the practice of "information control" on non-weapons data. The most striking example of the use of secrecy in technical matters was the setting up of "restricted data" by the Atomic Energy Act of 1946. In addition to classifying, i.e., withholding publication and safeguarding information on the design and manufacture of atomic weapons, the Act designated as restricted data "all information concerning...the manufacture of fissionable material and the use of fissionable material in the production of power..." Now fissionable material is essential to an atomic weapon. If you do not have the fissionable material, you can't make a bomb. On the other hand, if you have the fissionable material, you do not have to make a bomb. The swords or plowshares choice is yours. In fact the choice is even more striking-fissionable material can be used for weapons or it can be used as a basic source of energy. The peacetime use is not a trivial luxury; it is a primary natural resource.

It is eight years now since the Atomic Energy Act was adopted. The language of the Act, as it pertains to control of technical information, is unchanged. The interpretation has changed. Congress gave the Commission exclusive right to declassify, i.e., remove the security restrictions, from any restricted data provided the Commission could determine that publication of the information "would not adversely affect the common defense and security." This determination is based on a balancing of value of the data to unfriendly nations versus value to our own national technical efforts. With this authority to declassify, the Commission has over the past eight years released a large body of technical data, withholding only that which in its judgement would be of substantial use to a potential enemy. The scope of the International

Congress on Nuclear Engineering is an indication of the degree to which technical publication is permitted under present AEC regulation.

Definition of Initial Policy

The initial policy was defined by a group of scientists meeting late in 1945 under the chairmanship of the late Dr. Tolman. The report which this committee prepared for General Groves pointed out that for a short range situation all data should be withheld from publication whereas, if the possibility of war were at least a decade or more in the future, almost all data should be published. This "long range" versus "short range" choice is basic to any secrecy policy. Because of the great post-war uncertainties and the emergence of the USSR as a definitely unfriendly power, the Commission had to take an intermediate position, actually tending toward the short range policy. Under this policy all basic scientific non-weapons data were released and so-called "technology" withheld. This meant, for example, that laboratory studies of basic chemistry of plutonium have been published but information on our large scale plant experience in producing plutonium has been kept classified. In the field of atomic weapons this policy has been narrowly interpreted. "Basic" data are usually interpreted as ultra-pure theoretical information, such as new mathematical techniques.

Since the Russian atomic weapon test of late 1949, this policy-hold technology, release basic scientific information-has been slowly changing. At the present time it is apparent that a restrictive policy on the publication of non-weapons technology is of questionable value. Two important factors

must be considered:

USSR Advances. The policy for controlling non-weapons as well as weapons data has been based for several years past on the desire to avoid any possible assistance to the USSR in her atomic weapons program. By August of last year the USSR demonstrated that she did not need to wait for our publication of technical information before achieving even thermonuclear weapons. This demonstrated progress of the USSR in the fission and fusion weapons arts tends to destroy confidence in the effectiveness of secrecy.

2. Nuclear Power. The remarkable progress and increasing optimism of the past few years in the development of power reactors indicates that a thriving basic industry is being born.

Presented at the International Congress on Nuclear Engineering sponsored by the American Institute of Chemical Engineers, Ann Arbor, Michigan, June 21, 1954.

While it may prosper in its first years on controlled information and while it may not be handicapped by the harness of security practices, still it is doubtful whether the nuclear power industry can become fully grown without casting off the paraphernalia of the toddler. In other words, it is doubtful whether the nuclear power industry can develop full strength under the present conditions of information control set by governmental fat.

These facts have been recognized by the Commission. At first, in 1950, essentially all data on research reactors were published. During the intervening years more and more has been published about what can be done in a technical way with power demonstration units. At the present time there is still a very large body of classified reactor information, consisting principally of: (1) technical details on how to fabricate reliable reactor fuels, (2) performance data for nuclear fuels operated at elevated temperatures and in intense radiation fields, (3) the technology of separating plutonium and uranium from irradiated fuel elements. (4) an assortment of nuclear knowledge useful to power reactor designers. This body of classified information will be reduced in time, for it is the AEC's publicly stated policy to declassify reactor data as national activity in the field increases.

Effects of Declassification Policy

The dangers of an overly restrictive declassification policy are not generally recognized. Any broad national participation in the technical activities relevant to nuclear technology is possible only if a substantial body of information is in the public domain. Classified reactor information, for example, can be disseminated only under strict security safeguards and, although such dissemination can be on substantial scale, it is a slow and expensive process. Moreover, it is hardly consistent with free competitive enterprise since it is a government controlled activity. This slowdown in the flow of technical information cannot be ignored and passed off as "necessary for the national security." Rapid development of nuclear power is in itself a part of our national security

One aspect of the dangers of too much secrecy in non-weapons matters is that too restrictive circulation of technical data results in too few trained minds and hands. If only a few heads share the "secrets" of nuclear power, there will be only a correspondingly few hands to build new machines. An expansion in such an activity as manufacture of



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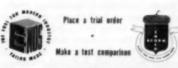


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nuclear plants a parines would be greatly retarded for lack of trained personnel. During the first few years of the Commission's program, many jobs were delayed by the requirements for on-job training. Now, because of a rational declassification policy, it is possible to minimize such delays. Basic training is now accomplished at the universities, engineering schools and at technical conferences.

We are going to have to live with the nucleus for many centuries. It would be a happy time if we could just shut up the whole business in a box and open it up at some time when we have achieved national and international maturity. But we cannot. Consequently, instead of boxing up the relevant technical information we must bring it out in the open. In this way the exploitation of the atomic nucleus for mankind's benefit can proceed at an increasing pace.

To put the problem in specific form, have we not now reached the stage in atomic development where we should release essentially all our technical data except that concerning the design and manufacture of the weapons themselves? This would be a return to the usual pattern of secrecy where devices are classified and not the widely useful components of the devices.

I recognize that limiting atomic secrecy to purely weapons information is a matter for future action. There will need to be considerable public discussion and possibly some Congressional action before the Commission could undertake such a program. However, I should like to predict that, just as it is inevitable that competitive nuclear power will be developed, so it is inevitable that peacetime non-weapons technical information will in time be essentially completely unclassified.

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Engineering Educators Stress Fundamentals

ENGINEERS should become more scientific, more creative and more human. This evaluation of current engineering education was the dominant theme of the 62nd Annual Meeting of the American Society for Engineering Education held June 14–18 on the Urbana-Champaign campus of the University of Illinois.

More than 1600 engineers, mostly teachers from colleges in every state of the union and many foreign countries, registered for the meeting. They urged each other to devote more time to the basic sciences, engineering science, and the humanities—at the expense of engineering art or practice.

Industrial employers, generally agreeing with the educators, said that they were unwilling to have colleges sacrifice the sciences and humanities to provide time for studying technology or administration. They insisted that their sales, manufacturing and operating departments (as well as their research and development divisions) need engineers with strong scientific backgrounds.

The extent of this move to strengthen science is shown by the proposal in an interim report of the ASEE's Committee on Evaluation of Engineering Education. This proposal would have all engineering students—whether majoring in chemical, mechanical, electrical, civil or other branches of the field—study in common almost five-sevenths of the total course. Only two-sevenths would be concentrated in the field of the major, and almost half of this as electives.

In his principal address of the meeting, Dean L. E. Grinter of the University of Florida, retiring president of the ASEE, said that colleges "must experiment with all possible methods of orienting engineering education more significantly toward basic and engineering science." He added that the greatest weakness of engineering education has been insufficient attention to integrating practice and specialized science so that students can understand the rules of engineering through their scientific knowledge. Dean Grinter said that the engineer must be inherently creative, putting together a combination of theories, concepts, techniques and experience in new patterns.

The emphasis on science was continued by Dr. Lee A. DuBridge, president of the California Institute of Technology, who spoke at a celebration of the fiftieth anniversaries of the engineering experiment stations at the University of Illinois and at Iowa

State College. "Maintain a close tie with the basic sciences," was Dr. DuBridge's advice. "An engineer, after all, is putting to practical use to-day what scientists discovered yesterday." Still more important, Dr. DuBridge stressed, is the fact that the work he must do tomorrow will grow out of what the scientist is on today.

"The main purpose of science," said Dr. DuBridge, "is not to produce bombs and guns and radar—or even radios, refrigerators and color TV, but to advance human understanding."

Despite the high purposes of science, too few high school students are being led to a study of science according to Major Lenox R. Lohr, president of Chicago's Museum of Science and Industry. Major Lohr told the attendants at the annual banquet of the Society that only 4 per cent of Chicago high school students are studying physics and no more than one-half per cent are studying solid geometry. "Uninspired and inept instruction have too frequently made these allimportant subjects a nightmare for the student," Major Lohr said. "The teacher should emulate the good salesman-be convinced of his subject's importance, know that his student has a vital need which he can supply, and induce the student really to want it by employing those devices which make it most palatable and persuasive.'

Engineering Manpower

A report based on a survey conducted by the Engineering Manpower Commission of the Engineers Joint Council provided information on the current demand for engineering graduates. It was concluded that the decline in business activity and defense orders in 1954 has led to a decrease in the requirement for engineering graduates of about 20 per cent. Yet despite this decrease, there is still a substantial unfilled demand.

Power Option in Electrical Engineering

A series of papers was presented on various phases of training power engineers through the power option in electrical engineering curricula. Dean W. A. Lewis of the graduate school of Illinois Institute of Technology evaluated areas in which the electric power industry is losing and gaining ground. He stated that in many fields of transportation electric energy has been losing the competitive battle, whereas it has been gaining in those applications where energy control in response to human or automatic evaluation of the need is the factor of prime impor-

tance. There should be an awareness of the competition between electric power and other forms of supply, and the future electric power engineer must be trained to be prepared for radical change, if and when it comes. Dean Lewis added that it is conceivable that a small reactor can be developed that can be installed in the individual home or small plant. If simplified controls are applied, the unit would be capable of supplying energy needs for many years without additional fuel or replacement of major components. If such a power source comes into being, it would almost eliminate any need for electric transmission and distribution systems. To meet such an eventuality, Dean Lewis contended that the electric power curriculum must be adaptable and provide sound fundamentals.

Prof. H. A. Peterson, chairman of the electrical engineering department of the University of Wisconsin, traced the dynamic growth of the electric power industry and concluded that some of the best engineering talent will be required to fulfill the needs of continuing expansion programs. Instead of discontinuing the curriculum in power, means must be found of reversing the trend which now finds both student and faculty interest at a very low point. Part of the educational task toward a renaissance of interest lies in developing an interest among teaching staff members of the opportunities in the broad field of power.

Commenting on opportunities for young graduates in the power field. Prof. J. A. M. Lyon of Northwestern University observed the colleges do not wish to teach men to do routine industrial jobs. He urged those responsible for developing engineering personnel to avoid emphasis on knowledge of equipment and to make use of special abilities possessed by recent graduates instead of limiting their vision by keeping them too long in sub-professional jobs. To train for the future, electrical engineers should be taught fundamentals of nuclear processes. For a power curriculum, additional elective courses in nuclear reactors and nuclear instrumentation seem desirable.

On the industrial side of the picture S. B. Crary of the General Electric Co. discussed essential requirements for power system engineering, observing that colleges can best provide the basic training and industry the specialized training. What concerns the power industry is that, with the

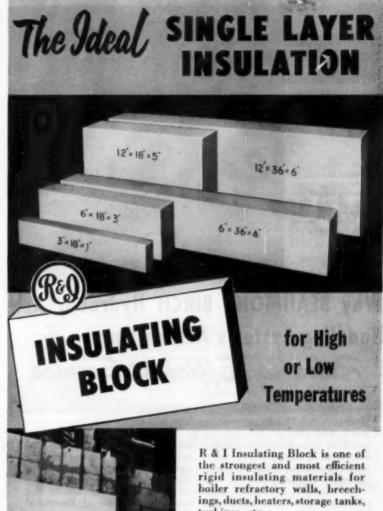
exception of several schools having power system engineering faculty, very few engineers are being trained in this speciality. Among the specific training which should be provided is the study of system and circuit analysis, use of symmetrical components and various types of analyzers and study of transient phenomena, rotating machinery and system stability.

George M. Keenan, director and vice president of the Pennsylvania Power & Light Co., stated that the work done by engineers in an operating electric utility covers such a broad range that opportunities for an engineering graduate are practically unlimited. He set forth eight elements of education for all engineers to have.

- 1. A sound foundation in and knowledge of the political organization of the United States at the federal, state and local levels, and of the American economic system.
- 2. A knowledge and realization of the necessity of working with and thinking of other people.
- 3. A basic knowledge of the fundamentals of business organization, labor relations and personnel administration.
- 4. An ability to organize his work and an appreciation of the value of time. Schedules must be met, decisions must be made, work must get done, not just started.
- 5. An appreciation of values in terms of the dollar no matter how inflated or deflated. We call this cost-consciousness.
- 6. A sound foundation in engineering mathematics, engineering physics, engineering chemistry, dynamics and the properties of engineering materials.
- 7. A broad knowledge and understanding of the language of engineers.
- 8. The ability to analyze problems, think clearly and express the thoughts logically, both orally and in writing.

Discussion

There was considerable discussion, much of it centering about the extent to which both student and faculty interests have shifted in the direction of the electronics option. In some schools, the percentage of electrical engineers selecting the electronics option is reaching as high as 90 per cent. One professor explained this trend on the basis that nearly all students must enter the armed forces, and there a knowledge of electronics proves of immediate and definite help.



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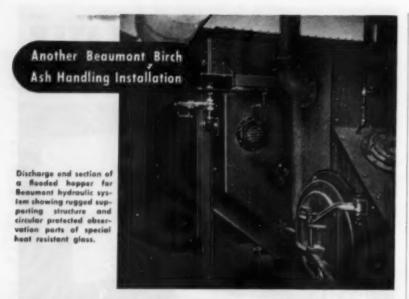
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For complete details of the many efficiency and economy features of Beaumont Hydraulic Ash Handling Systems, call in a Beaumont Birch engineer or write direct. There is also a wide-spread feeling that little additional research is necessary on electrical machinery and that this area has lost its challenge.

On the other hand, Dean L. V. Bewley of Lehigh University expressed the opinion that there is a more natural marriage between the electrical engineering power option and mechanical engineering than between the power and electronics options within electrical engineering. In his opinion the future of electronics is more closely allied with physics than with the power option of electrical engineering. There is need to break down the idea that power engineering is passé and to find more faculty members who have had a power background and genuine enthusiasm for the field.

Creativity in Engineering

M. S. Gjesdahl of the mechanical engineering department of The Pennsylvania State University observed that one of the basic requirements for consideration of education for creativity is an uninhibited mind. Also, a sense of dissatisfaction with routine procedure is helpful. He described a course in applied machine design in which a term design problem was assigned and the students were required to justify and clarify the design before a panel of three faculty members. The latter evaluated the design on the basis of originality and presentation, engineering design and production.

Undergraduate Mathematics

In a paper entitled "A Report on One Current Effort to Revise the Undergraduate Program in Mathematics" Prof. G. Baley Price of the mathematics department at the University of Kansas stated that the Mathematical Association of America had appointed a Committee on the Undergraduate Program at a meeting late in 1952. This Committee has agreed that a revision of the undergraduate curriculum is desirable.

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By Cecil B. Ellis

Sponsored by The Conservation Foundation, this book deals with problems of water supply that will have to be solved within the next few decades. The author, assisted by members of the staff of Nuclear Development Associates, Inc., investigated the prospects for salt-water conversion in projected capacities of 1000 million gallons per day. A project of this size would be capable of irrigating about 200,000 acres of farm land or of supplying the daily needs of New York City. Theoretical power requirements for this quantity of fresh water are 108,000 kw, and an actual installation of about 1,000,000 kw would be required.

The wide range of processes investigated and the evaluations placed upon them by the author combine to make this book most fascinating reading. Among the processes and methods considered are electrolysis; magnetic-electric membranes; mechanical effects of pressure, vibration and rotation; effects of heat and rotation; liquid-surface and solid sieves; biological and charged-net membranes; electroosmosis; multiple-effect, compression, super-critical and solar distillation; and such chemical techniques as precipitation, adsorption and ion exchange.

By the nature of the subject much of the material in this book is highly speculative. But because it concerns a long-range problem of water supply and involves very substantial amounts of power, many engineers in the power field will find it of interest.

There are 217 pages in the book which sells for \$5.

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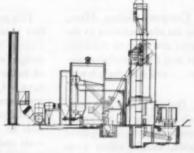
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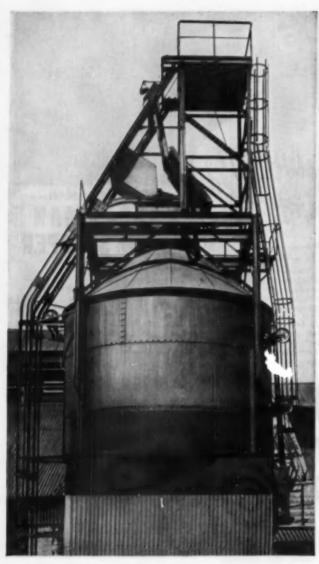
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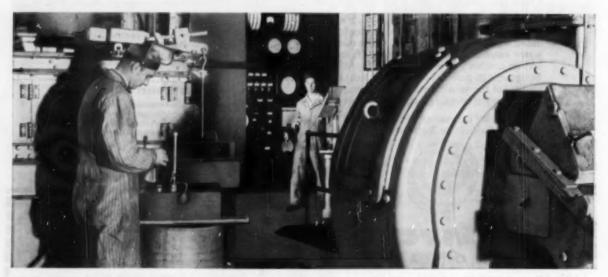
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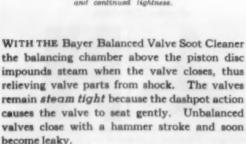
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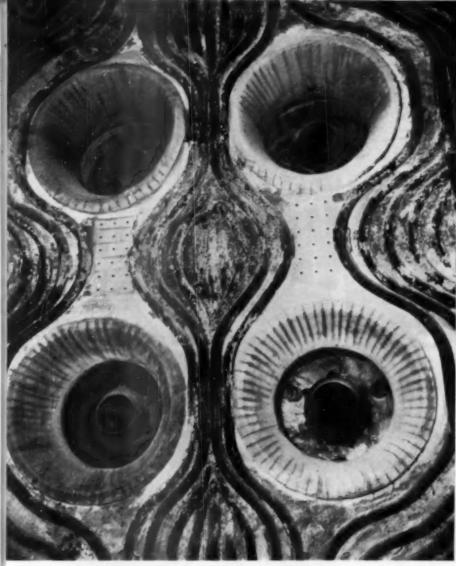
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THE COMBUSTION ENGINEERING "TYPE R" BURNERS shown are equipped with CARBOFRAX® refractory rings. These do not soften, even at extreme temperatures, so slag cannot fuse to the burner ring.

When slag builds up on fireclay burner rings in pulverized coal-fired boilers it's more than a minor annoyance. It distorts the flame. It fuses to the refractories. And when barred off, it takes big chunks of the ring with it. Sometimes these large pieces also dent the tubes when they fall. In short, slag formations cut down your operating efficiency, and run up maintenance.

The answer is CARBOFRAX® silicon carbide rings like those used with C-E "Type R" pulverized coal burners. This super refractory is so hard, and so dense that slag can't get a foothold. Moreover, it is practically immune to flame erosion, heat shock, and abrasion. An out-of-line burner, for example, which would cut away a clay ring in short order, has little effect on this refractory.

To summarize: CARBOFRAX refractories stay hard, to prevent slag buildup. They stay intact, and keep down repairs and replacements. And they stay on the line, and avoid costly shutdowns.

As an introduction, write for our free booklet. Address Dept. E-84, Refractories Div., The Carborundum Co., Perth Amboy, N. J. Or your nearest Combustion Engineering office can furnish information.

How
to
keep
burner
rings
clean...
flame
patterns
perfect



Registered Trade Mark







Fly Ash Problem Solved By Central Station

This Pennsylvania utility felt that as long as you can see dirty stack discharge, you have a problem. To solve it, they decided to insist on fly ash collection equipment with very high efficiency.

The electrical precipitators they chose, which were placed after existing mechanical collectors, are Cottrells, designed and built by Research Corporation. Their effectiveness is demonstrated in the above unretouched photographs. At the left, the precipitators were turned off long enough to take the picture showing the volume of fly ash discharged by the boilers. At the right, the precipitators are turned back on. Stack discharge is visually clean.

This is another example of industry's trend toward establishing its own higher standards for nuisance abatement. Research Corporation, which has made more fly ash installations than any other company, cites the following comparison:

In the period from 1923 to 1939 only 11% of its power plant customers specified fly ash collection efficiency of 95 to 98%. In recent years, that 11% has risen to fully 90%.

One reason, of course, is the generally increasing emphasis on community relations. Another factor is that farsighted companies are anticipating stricter smoke regulations. They are anxious to install equipment that will end their smoke problems now and also prevent such problems from occurring in the future.

Still another factor is this. In recent years, with modern coal pulverization and advanced boiler design, there has been an increase in the fineness of fly ash particles. This calls for the most efficient equipment available.

Read—in Bulletins FA and MI—about Cottrell equipment and the Research Corporation's MI Rapper. This device eliminates rapping puffs and enables the precipitator to maintain, continuously, its high collection efficiency. Write for your copies today.

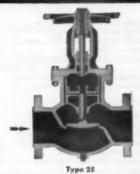
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FOSTER IN THE STEAM PLANT



NON-RETURN VALVES

Foster Automatic Non-Return Stop and Check Valves are made for pressures up to 900 P.5.1. and 900°F. Globe, angle or elbow pattern body design; 2½" to 12"

SAFETY VALVES

Foster Super-Jet Safety Valves for steam pressures up to 3000 P.S.1. and 1100°F, tight seating, have high relief capacity, pop accurately, are adjustable for minimum blaw-down and can be completely serviced in the line. Flonged or welding ends.



Type 38-51



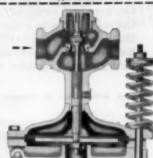
Type 50-G2S

PRESSURE REDUCING

Foster 50-G2 Regulators for high pressure steam are internal pilot operated for extreme accuracy approaching instrument type control. They handle a very wide reduction and often eliminate the need for a secondary stage valve. Self-contained or arranged for remote control.

PRESSURE REDUCING VALVES

Foster J-1A Regulators for low pressure are spring loaded, diaphragm actuded. They are designed primarily for steam heating systems, and are especially suitable for intermittent or dead-end service where the required reduced pressure is relatively close to the available inlet pressure.



Type J-1A

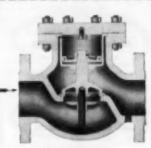


FLOW TUBES

The Gentile Flow Tube is an impact type head meter or differential producer for extremely accurate measurement of fluid flow. It requires no straight runs unless installed near throttling valves or regulators. Each tube furnished with in dividual head copacity curve.

CHECK VALVES

For positive, noiseless operation, Foster Cushion Check Valves are available in suitable materials and construction for either high or law pressure lines. Bodies are streamlined for minimum pressure drop.



Type CKH



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Foster Automatic Regulating Valves for controlling pressure, temperature or level are built to suit your requirements. Each type of do it well. Sizes range from 1/4" to 20" destions. Catalog 80 on request. Representatives

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Inside a boiler, you can't improve on new steel or steel newly cleaned. All you can hope to do is keep it that way—a task that often tries every known resource of boiler operation and maintenance.

Against the metal-destroying forces that can be unleashed inside steam-generating pressure vessels, there is one unique defense—unique because nothing else duplicates its service inside a boiler.

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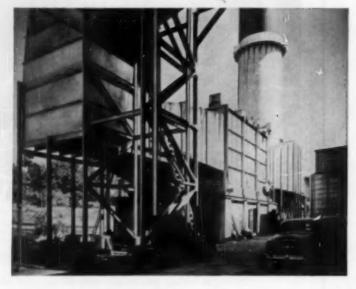
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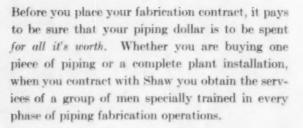
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